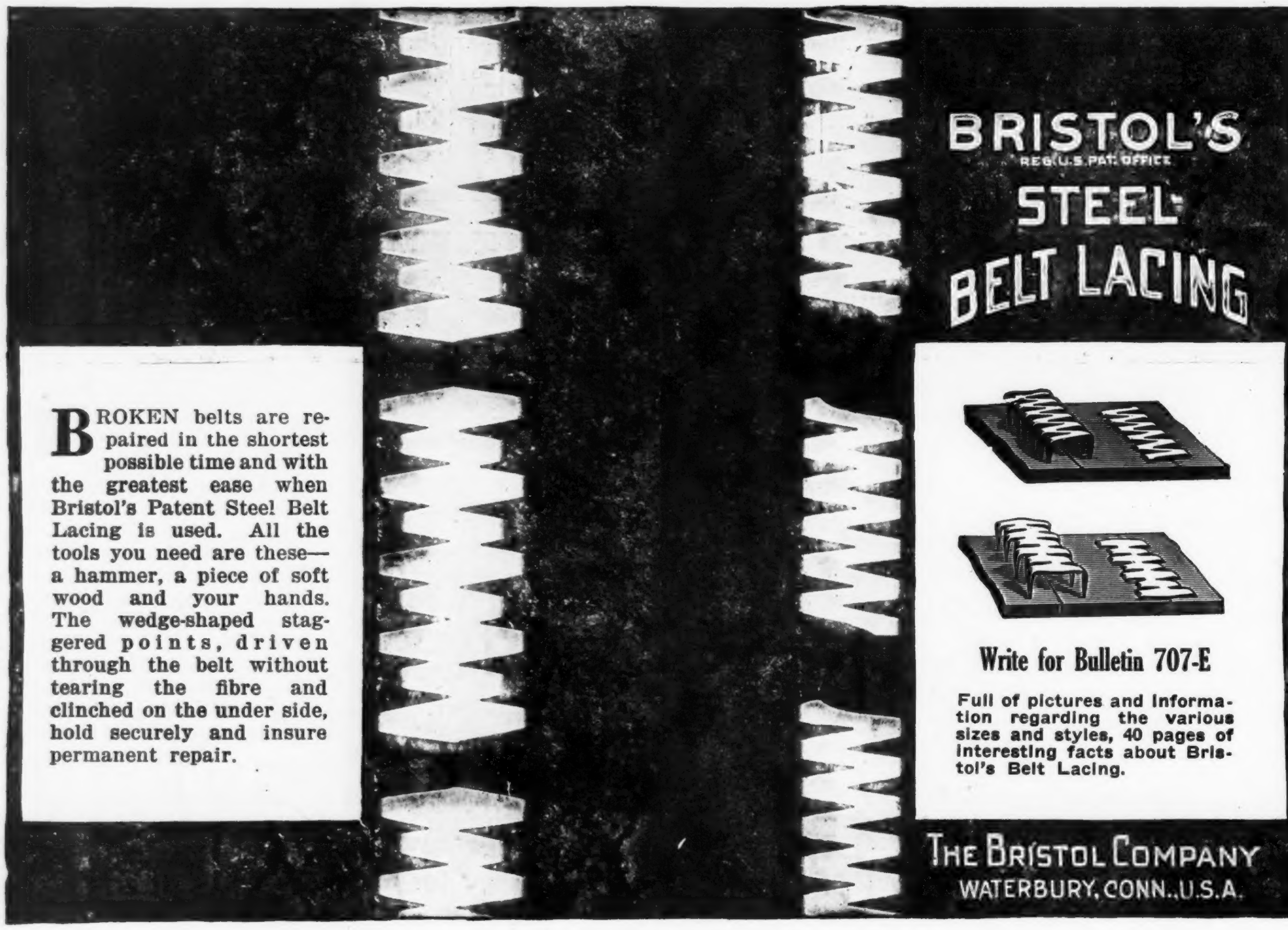
VOLUME 23 | JUNE 1917 | NUMBER 10

THE LARGEST MECHANICAL CIRCULATION IN THE WORLD

MACHINERY

PUBLICATION OFFICES 140-148 LAFAYETTE STREET, CORNER HOWARD, NEW YORK



LINDE OXYGEN

SERVICE — EFFICIENCY — CONVENIENCE — ECONOMY

From Coast to Coast 53 Plants and Warehouses provide an unlimited supply of LINDE OXYGEN for thousands of users everywhere.

Linde Oxygen may be obtained direct from any of our plants or warehouses. Mail or 'phone your order to THE LINDE AIR PRODUCTS CO., at any of the following points.

DISTRIBUTING STATIONS

ALABAMA
Birmingham (Plant)
10th Ave. and 28th St.
COLORADO
Denver
1550 Glenarm St.
DISTRICT OF COLUMBIA
Washington
9th and Maryland Ave., S.W.
GEORGIA
Atlanta (Plant)
Plyant St. and Southern R.R.
Savannah
Ogeechee Canal, So. of Bay St.
ILLINOIS
Chicago (North Side)
113 Austin Ave.
Chicago (West Side)
1501 S. Peoria St.
East St. Louis
6th and Walnut Ave.
INDIANA
East Chicago (Plant)
Fort Wayne
414 E. Columbia St.
Indianapolis (Plant)
2819 Roosevelt Ave.
IOWA
Davenport
118 Harrison St.
Des Moines
117 W. 5th St.
KENTUCKY
Louisville
126 E. Main St.
LOUISIANA
New Orleans
861 Fulton St.
MARYLAND
Baltimore (Plant)
25th and Montebello Ave.
MASSACHUSETTS
Cambridge
25 Waverly St.
Springfield
Napier St.
Worcester (Plant)
961 Southbridge St.
MICHIGAN
Detroit (Plant)
St. Aubin Ave. and Newton St.
Grand Rapids
Pearl St. by the Bridge
MINNESOTA
Duluth
Seventh Ave., West
Minneapolis (Plant)
1809 E. Hennepin Ave.
MISSOURI
North Kansas City (Plant)
14th and Charlotte St.
St. Louis (Plant)
4218 Forest Park Blvd.
NEBRASKA
Omaha
1007 Jones St.
NEW JERSEY
Elizabeth (Plant)
Linden Ave.
Newark
354 Plane St.
NEW YORK
Albany
Montgomery and Colonie Sts.
Brooklyn (Plant)
475 Driggs Ave.
Buffalo (Plant)
155 to 183 Chandler St.
New York City
217 W. 29th St.
Utica (Plant)
Walnut and Schuyler Sts.
OHIO
Cleveland (Plant)
E. 73d and Bitten Ave.
Cincinnati
63 Plum St.
Columbus
310 Dublin Ave.
Dayton
521 E. First St.
Toledo
414 S. Erie St.
OKLAHOMA
Oklahoma City
27 E. Grand Ave.
Tulsa
1 North Boulder St.
PENNSYLVANIA
Norristown (Plant)
No. Philadelphia (Plant)
18th and Cambria Sts.
Pittsburgh
16th and Pike Sts.
Trafford (Plant)
TENNESSEE
Chattanooga
212 to 238 King St.
Memphis
203 Washington St.
WISCONSIN
Milwaukee (Plant)
36th St. and National Ave.

PACIFIC COAST

CALIFORNIA
Emeryville, Oakland (Plant)
Los Angeles (Plant)
1405 Mission Road
OREGON
Portland
15th and Hoyt Sts.
UTAH
Salt Lake City
112 West Second St., South
WASHINGTON
Seattle
530 First Ave., South
TEXAS
Dallas (Plant)
Harwood and Coombs St.
Houston
Cedar and Baker Sts.
San Antonio
512 Dolorosa St.

THE LINDE AIR PRODUCTS COMPANY, FORTY-SECOND STREET BLDG. NEW YORK, N. Y.

LARGEST PRODUCERS OF OXYGEN IN THE WORLD

Other Plants are planned for other industrial centers throughout the country and will be established as fast as and wherever the local demand for oxygen warrants.

JUNE MACHINERY 1917

Making Precision Screws for Scientific Instruments

by Edward K Hammond[1]

Methods are described in the following article for cutting and testing precision screws for astronomical and other scientific instruments. These screws are sold under a guarantee that the error in lead does not exceed 0.001 millimeter, i. e., approximately 0.00004 inch, from a theoretically accurate helix of the same lead. This degree of accuracy is greater than that required in any ordinary shop work, but the principles described should prove of value in shops called upon to cut highly accurate lead-screws, etc. The article includes instructions for using two forms of interferometers, one of which provides means for measuring to one-millionth inch.

IN ordinary machine shop practice the standard of workmanship is considered satisfactory if the error in machining does not exceed 0.001 inch. On tool-room work, where greater care is taken than in the average manufacturing operations, a considerably higher limit of accuracy may be attained, but highly skilled toolmakers of wide experience will feel satisfied with a piece of work if they are sure that the limit of error is not over 0.0001 inch. In any class of shop work, it is a waste of time, and entails a deliberate loss of production, to strive for a higher degree of accuracy than is absolutely necessary, and the limits referred to for the manufacturing plant and the tool-room have been found to mark the boundary line between products that will give good service and those with which unsatisfactory results are likely to be experienced through difficulty in assembling, failure to operate properly, and similar troubles.

In making parts of scientific instruments, the case is very different, because here errors which would be quite insignificant in any commercial work may be multiplied as a result of conditions under which the instruments are used, so that data obtained with inaccurate apparatus would be highly misleading instead of a means of furnishing valuable information. A case in point is seen in astronomical and physical instruments—say micrometers and comparators. Micrometers are used in connection with astronomical telescopes for determining the distance between the stars, or with spectroscopes for locating the position of spectrum lines, etc., the measurements being made directly with the micrometers, while with comparators or measuring machines the measurements are made on photographs of the stars or spectra. When using a comparator, the cross-hair of a microscope on the comparator is first centered on one star, after which the position of the microscope is noted. It is then moved by means of a screw until the cross-hair is centered on another star; and the distance between these two stars on the photograph is determined by the number of turns made by the screw. The actual distance between the two stars is then calculated from these data and other information at the disposal of the astronomer. Very little thought will make it apparent that in order to secure data that constitutes a reliable basis of calculation, the comparator screw must be of the highest accuracy, because a slight error in setting the instrument is multiplied many times, due to the great distance of the stars from the telescope and the multiplication of an error of arc with increase of distance from the center.

Realizing the importance of this point, instrument makers and scientists have given a great deal of thought to the development of methods for eliminating every possible error in screws, and this has been made the subject of exceptionally careful study by William Gaertner & Co., 5345 Lake Park Ave., Chicago, Ill., to whom we are indebted for information concerning the interesting methods of precision screw cutting described in this article. Errors in screws may be either "periodic" or "progressive." When a screw has a periodic error, it has what is commonly known as a "drunken" thread; the inaccuracy appears in every revolution of the screw, and usually proceeds in regular intervals from zero to a maximum error and back again to zero. In case the screw has progressive errors, it has the well-known errors of pitch, *i. e.*, the

[1]Associate Editor of MACHINERY.

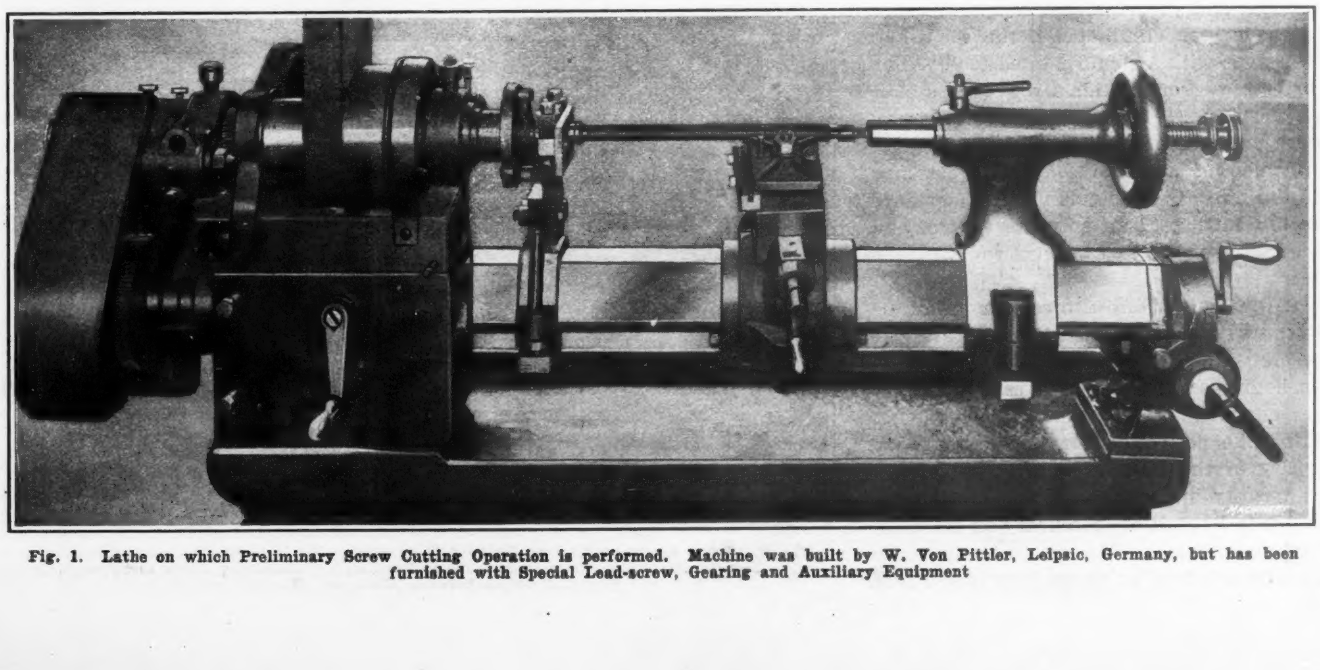


Fig. 1. Lathe on which Preliminary Screw Cutting Operation is performed. Machine was built by W. Von Pittler, Leipsic, Germany, but has been furnished with Special Lead-screw, Gearing and Auxiliary Equipment

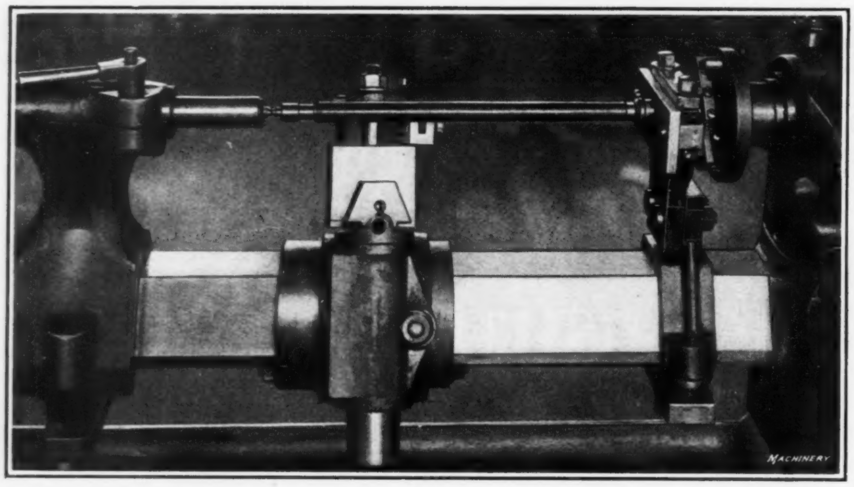


Fig. 2. Close View of Tool, Work and Work-holding Device taken from Back of Machine

pitch of the thread is not uniform throughout the entire length of the screw, so that when turned in a nut such a screw advances different amounts for different revolutions. From this it will be evident that a progressive error is entirely irregular.

In screw cutting, the operation of a lathe is chiefly governed by the familiar lead-screw and change-gears, and accuracy of the product of a screw cutting lathe is largely dependent upon the precision of its lead-screw and gears and the straightness of the lathe bed. So far so good, but the man who starts making a study of methods of precision screw cutting will eventually ask himself the question, "Where did the first lead-screw come from and what is responsible for its accuracy?" There are various methods of originating screws, and for the purpose of this article it will be satisfactory to describe one employed by the late C. Reichel, a celebrated instrument maker of Berlin, Germany. This method consisted of taking wire of uniform diameter and, say, exactly one millimeter in size, which was closely wound and soldered onto a mandrel and mounted on the lathe spindle. The lathe used for this work was what is known as a "sliding mandrel lathe," and this type of machine is still in use in instrument shops for chasing short threads. Mr. Reichel then made a multiple thread cutting tool of the chaser type, which had the teeth very accurately spaced, and proceeded with this to cut down the wire to form a screw thread.

The cutting tool was held stationary in the slide-rest, and a block of hard wood, also held stationary on a separate support, formed the nut or guide for the screw mandrel, the cutting tool and nut being 180 degrees apart. When the lathe was slowly run forward, with the cutting tool in contact with the wire thread, it was observed that the tool did not touch uniformly, but showed a "wobbling" tendency in the thread, and usually touched one high spot in each revolution. The multiple tool was the means of correcting both periodic and progressive errors that could not have been eliminated if the work had been done with a single-pointed tool. After correcting errors in this screw, it was used as a "master" from which other screws were cut. In all precision screw cutting, provision of accurate concentric bearings on the screw is of just as much importance as the cutting of an accurate thread, and the nut must be fitted to the screw with the greatest care.

It will be of interest to refer at this time to the way in which periodic or progressive errors are developed while cutting a thread. In both cases, a variety of causes may be responsible for the trouble, but as a general thing the periodic error is due to eccentricity of the lathe spindle or to lack of uniformity in the gearing on the lathe, which is a result of inaccuracy on the gear-cutting machines. The errors in the gears become effective at those intervals where the teeth in which there are errors come into mesh, and at such times an error is introduced in the screw cut on the lathe through lack of uniformity of movement of the lead-screw on the lathe. Production of screws with a so-called progressive error or errors of pitch is harder to explain than the screw with the periodic error, because the discrepancy follows no fixed rule. This error may be due to inaccuracy in the gears, to lost motion in machine members, lack of straightness of the lathe bed, or to numerous other causes.

Gaertner Practice in Screw Cutting

In making precision screws, observance of the following points is a matter of great importance if accurate results are to be obtained: (1) The steel must be fine grained and homogeneous. (2) After roughing out the thread, the screw must be carefully examined to see that no defects in the steel have been exposed during the process of screw cutting. (3) The rough-cut screws must be put aside to "season" for several months so that they will take the full "set" developed through removal of the surface skin from the metal, after which the finishing cuts may be taken with the assurance that there will be no further distortion. In the Gaerther shop, the preliminary work of screw cutting is done on a lathe of German manufacture made by W. Von Pittler of Leipsic. However, the design of this machine has been considerably modified and many details have been improved or entirely renewed to adapt the machine for the precision work for which it is now used. The provision of an accurate lead-screw and gearing are typical examples of the changes that were made. In cutting screws for astronomical or similar instruments, precautions must be taken to avoid the introduction of errors of such slight magnitude that they could be entirely disregarded on many classes of commercial work.

Reference to Figs. 1 and 2, which show a front view of the lathe on which the preliminary screw cutting operations are conducted and a close view of the tool and work taken from the opposite side of the machine, respectively, will show that, instead of setting up the work in the usual way, the screw is mounted on stationary centers, *i. e.*, dead centers, and the cutting is done on the same bearings on which the screw is afterward used in the apparatus for which it is intended. Clamped to one end of the screw is a dog which engages the lathe spindle and provides for rotating the screw. It will be apparent that the chief reason for this method of procedure is that it insures cutting the thread on the screw in accurate

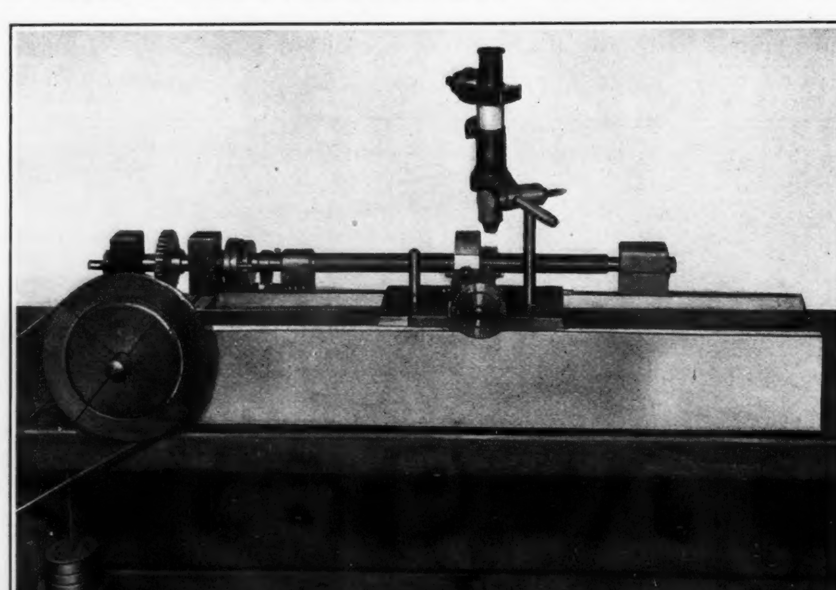


Fig. 3. Screw Recutting Machine designed to operate on Principle shown diagrammatically in Fig. 4. Particular Attention is called to Bearings for supporting Screw to be recut, and Special Coupling between Work and Machine Spindle

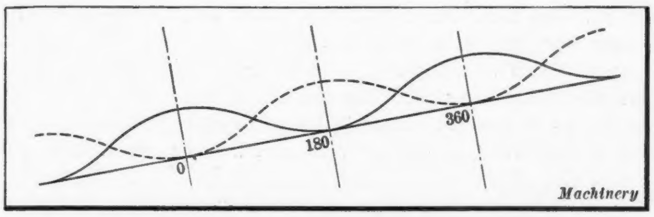


Fig. 4. Diagram showing Possibility of designing Screw Recutting Machine that automatically regulates Depth of Cut according to Error in Lead of Thread

alignment with the bearings that have already been turned at the ends of the screw blank; in addition, slight inaccuracies that might be introduced in the screw as a result of belt pull and slight errors in the lathe spindle bearing are overcome. With the work set up in this way, the method of cutting the screw is practically standard, except that after roughing out the thread, the screw is set aside to season, as mentioned.

Recutting Machine for Removing Periodic Errors from Thread

Various means have been tried for eliminating the periodic error from screw threads, but the method of recutting used by William Gaertner & Co. is among the most satisfactory. Credit for the development of this method is given to the late C. Reichel of Berlin, Germany; and the theory of this operation is best shown by reference to the chart presented in Fig. 4. Both curves show the way in which a periodic error in a thread runs from zero to a maximum and back again to zero during a period required for one revolution of the screw. After grasping the full significance of this fact, it was realized that by recutting the screw with a tool carried on a slide, the position of which could be governed according to the amount of correction required at different points on the thread, it would be possible to make the thread absolutely accurate. This result is obtained by the use of a nut, consisting of a single V-shaped point, which enters the thread. It will be seen that the nut is carried on a yoke that extends over from the slide, and different settings may be made, so that the nut is placed 180, 90 or 45 degrees from the tool. Fig. 4 shows diagrammatically the conditions that exist when the nut is set 180 degrees from the recutting tool. Here it will be noticed that when the nut engages the screw thread at a point of maximum error, the tool lying opposite the nut engages the thread at a point where there is no error. Conversely, when the tool is at the point of maximum error, the nut is at a point where the error is zero. In this way the nut moves the tool-slide along the bed and advances the tool to the work at a rate that is governed by the amount of error to be removed from the screw thread at the point where the tool is working. A counterweight, connected to the tool-slide by a cord, relieves the screw thread and nut of much of the strain incident to moving the tool-slide along the bed of the machine.

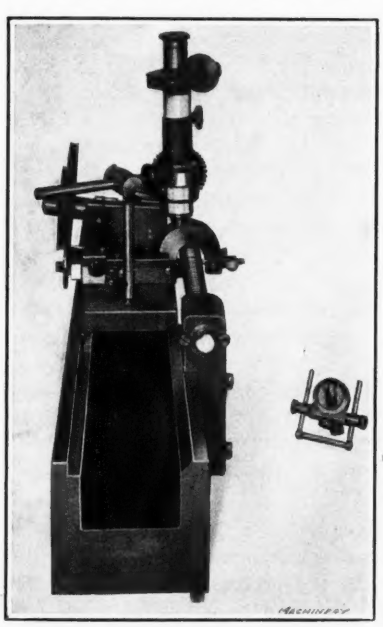


Fig. 5. End View of Machine shown in Fig. 3, showing Yoke that supports Nut and Tool

A recutting machine operating on this principle is shown in Figs. 3 and 5; the best idea of its method of operation will be gathered from the end view, where it will be seen that the nut is located at the back of the screw, and the cutting tool at the front of the screw to correspond with the conditions shown diagrammatically in Fig. 4. When the nut is at a point of maximum error, the tool is opposite a point of zero error, and is clear of the work, so that no cut is being taken. After the screw has made one half turn, so that the nut comes to a point of zero error, the tool-slide has advanced so that the tool is taking a cut of maximum depth. Of course, for intermediate positions, the depth of cut ranges between zero and the maximum. The amount of metal removed during this recutting operation is extremely small. Viewing the operation of the tool with the naked eye, one would say that the tool was not in action, but when observed through a microscope provided on the machine for that purpose, one can easily see how the tool starts to take a very light cut, which gradually increases and leaves a fine dust of metal on the lip of the tool.

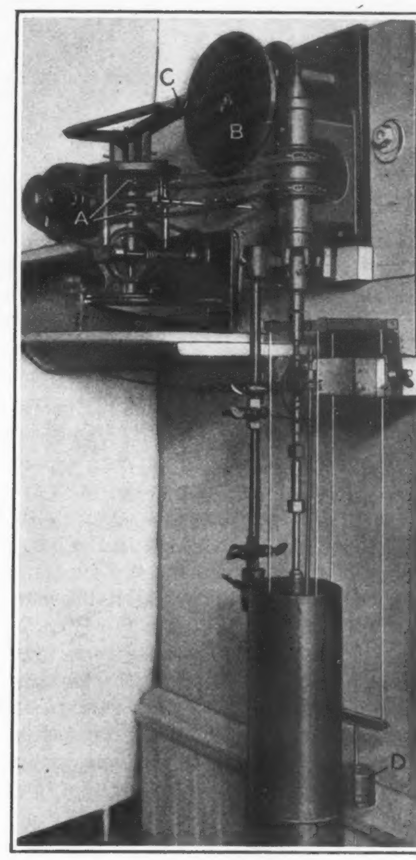


Fig. 6. Automatic Lapping Machine for imparting High Finish to Screw Thread after it has been recut

One traverse of the cutting tool over the screw, with the nut set at 180 degrees to the tool, results in reducing the error in the thread to one-half its previous magnitude. After taking this cut, the nut is transferred to the 90-degree position and a second cut is taken, which results in again dividing the error in half. Then the nut is set so that it is at 45 degrees from the tool, and a third cut is taken, which once more divides the existing error in half. In this way the final error in the thread is only 12½ per cent of that which originally existed, and as the original screw cutting operation performed on the Von Pittler lathe was done with every possible care, it will be apparent that the accuracy of the finished screws is extremely high. As a matter of fact, screws are sold under a guarantee that the error in lead will at no point exceed 0.001 millimeter, *i. e.*, 0.00004 inch from the path of a theoretically accurate helix, although far greater accuracy has been secured. The attainment of such a degree of precision will certainly be appreciated by every skilled mechanic.

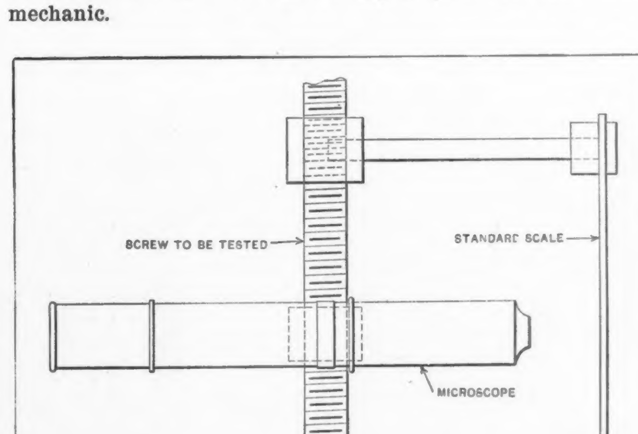


Fig. 7. Method of testing Accuracy of Precision Screw with Microscope and Standard Scale

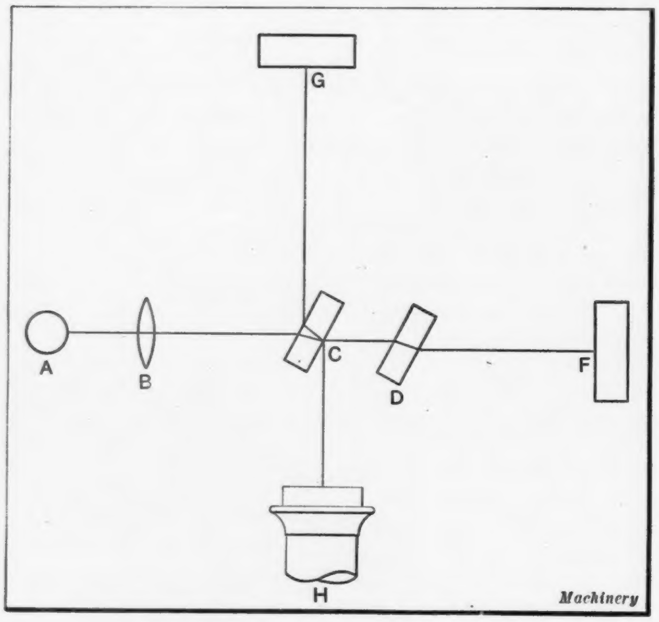


Fig. 8. Simple Form of Interferometer Suitable for Use in testing Precision Screws and for making Other Forms of Accurate Measurements

To obtain such a degree of accuracy calls for a machine operating on the principle described, that is, making the periodic error at one side of the screw adjust the position of the tool to eliminate the error at the opposite side. But this would be inadequate if great care were not taken in constructing the machine and setting up the work to obviate lost motion and other troubles of a kindred nature. In building the machine, great care was taken to obtain the best possible fit for all bearings and slides, and have the guides absolutely straight. In setting up the work, corresponding care is taken, the ultimate object being to bring the axis of the screw exactly parallel to the guides, and to eliminate every possibility of lost motion. Instead of being satisfied with mounting the screw on centers, it will be seen that bearings are provided which are carefully fitted so that the accurately finished bearings at each end of the screw will be carried in them without chatter or vibration. On the spindle there is a faceplate to provide for driving, but if the screw were driven through a dog, there is little doubt that strains would be developed that would result in errors, so that the accuracy of the thread would be impaired during the process of recutting instead of improved. As a substitute for the dog, it will be seen that a special form of coupling is provided between the lathe spindle and work. This coupling compensates for any lack of alignment, and relieves the work of all strains that might be put upon it through the use of the usual form of driving dog.

Lapping Screw to Polish Thread and Reduce Error

Before adopting the practice of recutting screws on the machine shown in Figs. 3 and 5 to eliminate the error, the screws were lapped in a machine of the type shown in Fig. 6. It will be seen that the machine is furnished with a universal joint that drives a chuck in which is carried the screw to be lapped. This machine is driven by an electric motor that transmits power by means of a belt and worm drive to a vertical shaft on which are mounted two sprocket wheels *A*. Located between these sprockets is a clutch, which may be engaged with either sprocket to provide for driving through the open or crossed chain to get forward or reverse rotation of the main spindle of the machine. The control of this clutch is effected by means of a small worm at the upper end of the main spindle, which drives disk *B* by means of a worm-wheel and spur gears.

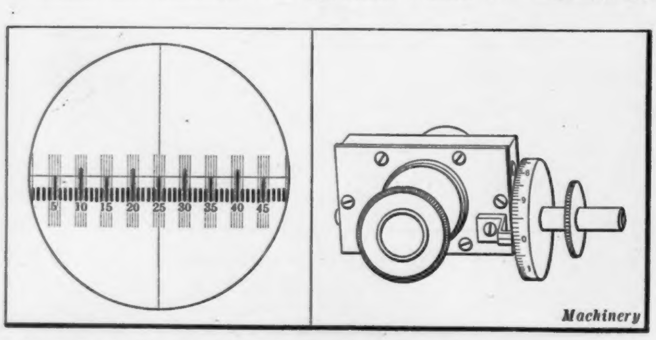


Fig. 9. Appearance of Interference Fringes and Scale in Eye-piece of Telescope; and Micrometer Head for recentering Scale Graduations on Fringes

Holes are drilled around the periphery of this disk, into which two stop-pins may be fitted; these pins are set to give reversal at the desired point. This result is obtained by having the pins strike lever *C*, which throws over the clutch between sprockets *A* and reverses the drive. When this is done, disk *B* runs back in the opposite direction until the other pin in the disk strikes lever *C* from the opposite side, when the clutch is thrown in the opposite direction and the machine once more reverses. The reservoir in which the screw rotates is filled with a mixture of oil and the finest grade of emery. Closely fitted to the screw there is a long nut, which is supported by counterweight *D*. The nut runs up and down the screw with each reversal in direction of rotation; and by having its weight removed from the screw, there is no tendency to introduce unequal wear on the screw thread. A stirring device keeps the mixture of oil and abrasive thoroughly agitated. This consists of a number of small propeller blades mounted on a vertical shaft, which is driven by the same motor that drives the machine. In this way the lapping nut is constantly supplied with fresh abrasive, and the fine particles of steel and worn particles of abrasive are washed out of the nut. Anyone who is familiar with the process of lapping a screw knows what damage would be done by allowing small steel chips to remain mixed with the abrasive material, and to avoid trouble from this source several strong magnets are suspended in the tank to collect these chips as fast as they are produced.

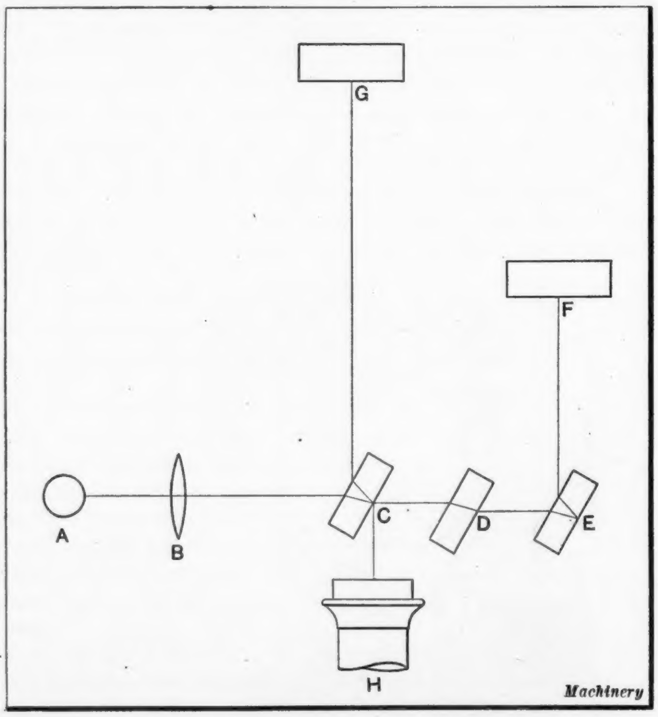


Fig. 10. Diagram showing Principle of Operation of Interferometer shown in Figs. 11 and 12

Mention has already been made of the fact that William Gaertner & Co. are prepared to furnish screws under a guarantee that the error in lead does not exceed 0.001 millimeter. Of course, to give a guarantee with a screw means that it will have to come up to the specifications, and so each screw has to be properly tested before it is sent out from the shop. Now to investigate the accuracy of a screw throughout its full length is a tedious and laborious proceeding, and is usually left to the scientist who is going to use the instrument of which the screw forms a part. For instance, to test a screw for one of the small comparators of 3¼ inches or 80 millimeters range, employing the microscope method of testing, requires about a month of the observer's time.

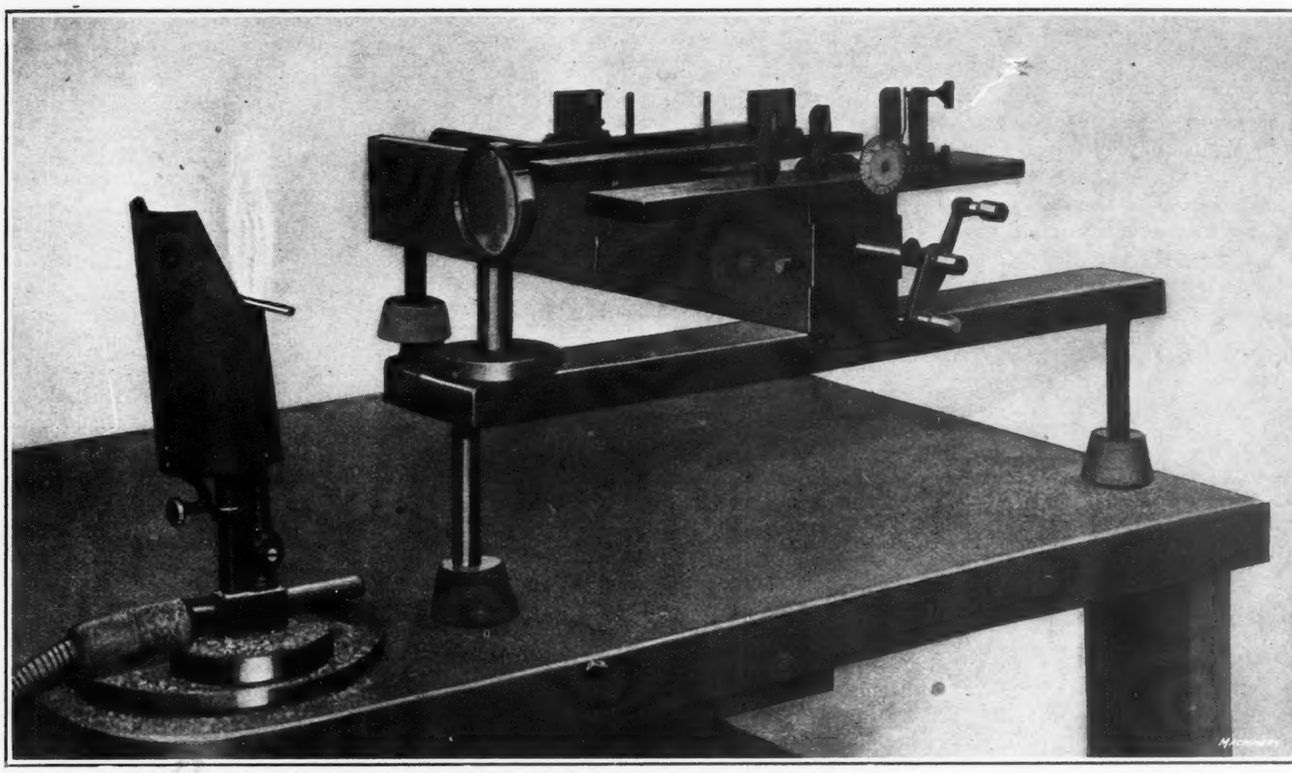


Fig. 11. Special Application of Interferometer Principle for rapidly testing Accuracy of Precision Screws. This Test shows whether Error is Periodic or Progressive, and whether Maximum Allowable Error is exceeded, but Results are Qualitative rather than Quantitative

In testing a screw in the laboratory, the work is usually done on the completed instrument; and a microscope of suitable magnifying power, having a fine wire (spider thread) in the eye-piece, and an accurately divided scale are employed. The microscope may be carried on the slide which is moved by the screw or it may be held stationary on the frame of the apparatus and the scale placed on the slide. If the microscope is movable, the scale is placed on a stage below and carefully adjusted to be parallel with the axis of the screw. Suppose the pitch of the screw is 1 millimeter, the scale will be divided up into spaces of 0.1 millimeter. The microscope is focused on the scale and adjusted so that the spider thread in the eye-piece will bisect a scale mark. If the screw head has a graduated dial with 100 divisions and the microscope is moved to the next line on the scale, the reading on the dial should be ten divisions.

In moving the microscope from line to line on the scale, and observing the readings on the graduated dial, the screw is directly compared with the scale. Any discrepancy from the required readings on the dial for each corresponding movement of the screw indicates an error. But what about the error in the scale, and what about the errors that may be made in setting with the microscope? These are two uncertain factors to be figured with. The scale may be tested at the Bureau of Standards, so that the value of every scale division is known, and the error of setting may be eliminated by taking the mean of a number of readings; but anyone will see that testing a screw by this method is, at best, a slow and tedious proceeding and requires great patience and a trained observer, so that it would not be suitable for use in a shop.

Another and quicker method that has been used is to mount the microscope and scale on two separate carriages, which are moved by the screw, as shown diagrammatically in Fig. 7. The microscope cross-hair is adjusted to a scale mark, and if the screw is then turned, both the microscope and scale should advance the same amount if the screw is free of errors, and the scale mark should remain in the same position in the field of the microscope. Any shifting of the scale mark indi-

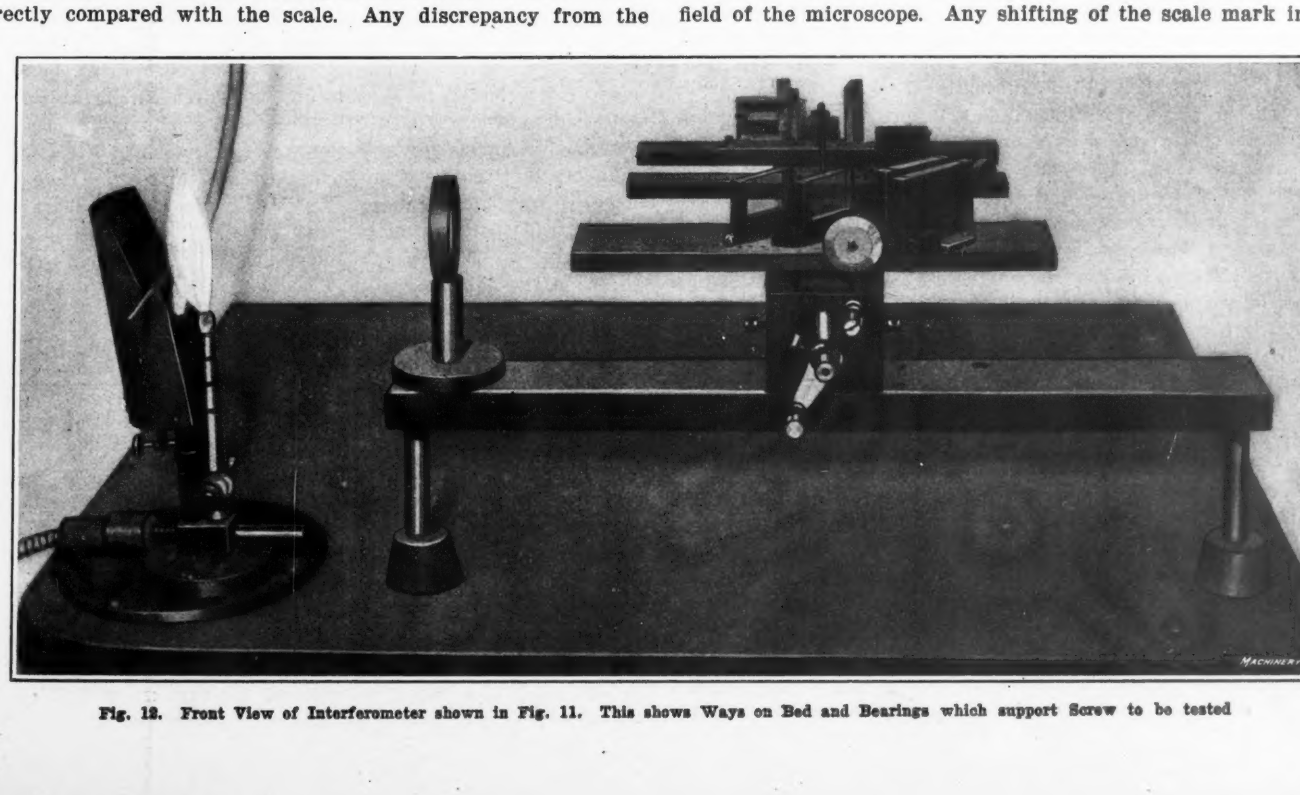


Fig. 12. Front View of Interferometer shown in Fig. 11. This shows Ways on Bed and Bearings which support Screw to be tested

cates an error in the screw, but it will only show the difference in pitch of the screw at the two places on which the nuts engage.

The most accurate and reliable method of testing the errors of a screw, or of measuring any small unit of length, is based on the application of interference of light waves, and this method is used in the Gaertner shops. It will be impossible in this article to enter into a detailed discussion of the theory of optical interference, which may be found in any standard book on optics. The instrument used for testing by this method is known as an "interferometer," and it is the means of obtaining the most accurate results in length measurements; this method has become identified with the name of Prof. A. A. Michelson, who has brought it to its present general form and has made the most extensive application of it in research work.

Fig. 8 shows the arrangement of optical parts of a simple form of interferometer. Light from a source *A* rendered approximately parallel by lens *B* is divided at surface *C* of the first glass plate into two beams, one passing on to mirror *F*, and the other being reflected to mirror *G*. After reflection from the mirrors, these beams of light are reunited at *C* and observed at *H* by a low-power telescope. The image from mirror *F* is seen in the direction of *CG*, and attention is called to the fact that mirror *G* makes an angle slightly different from 90 degrees with *F*, thus fulfilling the conditions of interference. Plate *D* (compensator plate) is of exactly the same thickness as plate *C*, thus producing similar optical distances in both paths *CG* and *CF*. In the usual form of interferometer, mirror *F* is held stationary and mirror *G* is moved by means of a screw. If both the mirrors and plates are properly adjusted, there will be seen at *H* what are known as interference fringes, which have the appearance of bands of high lights and shadows.

By adjustment of the mirrors the space between two adjoining bands may be made any desirable distance, say two to five millimeters. If sodium light is used which has a wave length of 0.000589 millimeter, the space between two bands represents one wave length, *i. e.*, 0.000589 millimeter, or 0.000023 inch. If now the cross-hair of the telescope is adjusted to the center of one band and mirror *G* is moved ½ wave length, or 0.000294 millimeter, the optical path *CGC* will be changed a full wave length and the next adjoining band will appear under the cross-hair. If the bands are adjusted, say, 5 millimeters apart, a travel of 5 millimeters in the telescope will be equal to a motion of the mirror of 0.000294 millimeter, or 0.0000116 inch, from which it will be seen what a high degree of accuracy is obtainable and that a one-millionth part of an inch can not only be estimated but actually measured.

Fig. 9 shows in diagrammatic form the appearance of the interference fringes in the eye-piece of the telescope when the interferometer is adjusted to space these fringes at intervals of 5 millimeters. By suitable adjustment, the fringes may be centered on scale graduations, but in order to provide for accurately measuring any given displacements, the telescope is provided with a micrometer, by means of which the scale can be moved in the eye-piece of the telescope. In this way the scale graduations can be brought back to the central position, and the necessary movement to so center the graduations is indicated by the micrometer dial. Error in centering the scale graduations on the interference fringes is eliminated by taking the mean of a series of readings. In testing screws, the interferometer is used similarly to the microscope and scale, Fig. 7, but instead of measuring the unit of length on the scale, light waves are used and the number of interference bands are counted in the telescope while turning the screw a fixed amount.

Every progressive instrument maker must have a method of testing which is capable of giving absolutely reliable information, but which is more rapid than the one just described. In the Gaertner shops such a method is provided by an application of the interferometer principle, as shown in Figs. 11 and 12; but probably a better understanding of the method of using this apparatus will be gathered from the diagrammatic view in Fig. 10, which shows the principle clearly. It will be seen that the equipment consists of a bed, in which are carried bearings for the screw to be tested. At the forward end of this bed there is a stand, on which are mounted two glass plates and one mirror, which receive light from the "sodium" gas flame *A*; the rays of light are concentrated by means of a lens *B* set up in the stand placed between the light and the first glass plate *C*. Sliding along the bed of the machine are two bars, on each of which are supported mirrors *F* and *G*. These mirrors must be carefully adjusted so that they are exactly parallel with each other. Each mirror stand carries a nut that consists of a single point which is a close fit in the thread of the screw to be tested; and such adjustment of the apparatus is made that interference bands appear in the field of the telescope.

Under these conditions, observation from the eye-piece of a telescope at *H* reveals the interference bands, which have the appearance of vertical bands of high light and shadow. As the handle at the front of the machine is turned, rotation of the screw causes the two bars supporting mirrors *F* and *G* to be traversed along the bed of the machine, and in the case of a periodic error in the screw, this results in causing the central fringe to first move slightly away from a cross-hair in the field of the telescope and then return to this cross-hair. In the case of a progressive error, the central fringe also moves away from the cross-hair in the telescope, but with an error of this kind the fringe may continue to move away instead of returning to the starting point. From the distance through which the interference fringes move in the field of the telescope, the observer is able to estimate the amount of error that exists in the screw thread, and if this error does not exceed that which is allowable, the screw is pronounced ready for use. If, on the other hand, a considerable error is discovered, it is necessary to correct this error or make a new screw. The advantage of this method of testing is that while it is not "quantitative," that is, does not show the actual amount of error that exists at each point on the screw thread, as in the method previously described, it does afford a rapid method of determining whether the maximum error in the screw exceeds that which is allowable. This is all that the instrument maker is interested in, and so the interferometer method is the means of saving him the expense of having men spend a large amount of time in testing the accuracy of each screw by the tedious micrometer-microscope method to which reference has been made.

* * *

THE METRIC SYSTEM IN GREAT BRITAIN

The question of the adoption of the metric system is apparently very much at the front in Great Britain, judging from the comment in all the British engineering journals. *Engineering*, as already mentioned in MACHINERY, leans toward the metric system. The *Mechanical World*, in an editorial entitled "The Metric System," while not over-enthusiastic about the expense that a change in weights and measures will bring with it, nevertheless states that "the prospects are in favor of the metricists." Among other bodies, the Institution of Electrical Engineers in Great Britain has asked the Board of Trade to make the compulsory adoption of the metric system part of the new trade policy of the British empire. The opposition to the system, which was very active some ten or twelve years ago, when the subject was last seriously considered, does not seem so active now. In engineering circles there is apparently no great enthusiasm over the prospect of a change, but rather an evidence of grim determination to accept the inevitable without making too much fuss. At any rate, it seems to be the plan to make the transition as gradual as possible, and this is, indeed, very necessary if the industries are not to be seriously upset. The bill that is proposed does not make compulsory the use of the metric system in the manufacturing industries, but simply requires that trading must be done in the new system. Should the British government adopt the proposition to introduce the metric system along these lines, it will be evident that the leaders of the industries in Great Britain are fully convinced that the step will not be detrimental to the nation, and that there will be a profit in the new system in the long run, although the expense at first will be heavy.

12

THE CUTTING TOOL AND THE CURLING CHIP

ANALYSIS OF CUTTING ACTION IN RELATION TO LUBRICATION

BY FRANK RICHARDS[1]

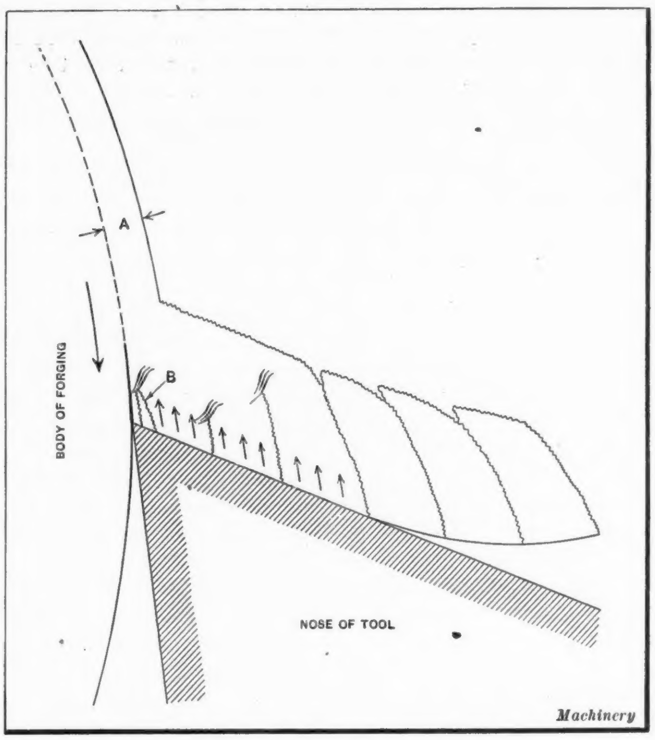


Fig. 1. Accepted Cutting Action of Tool

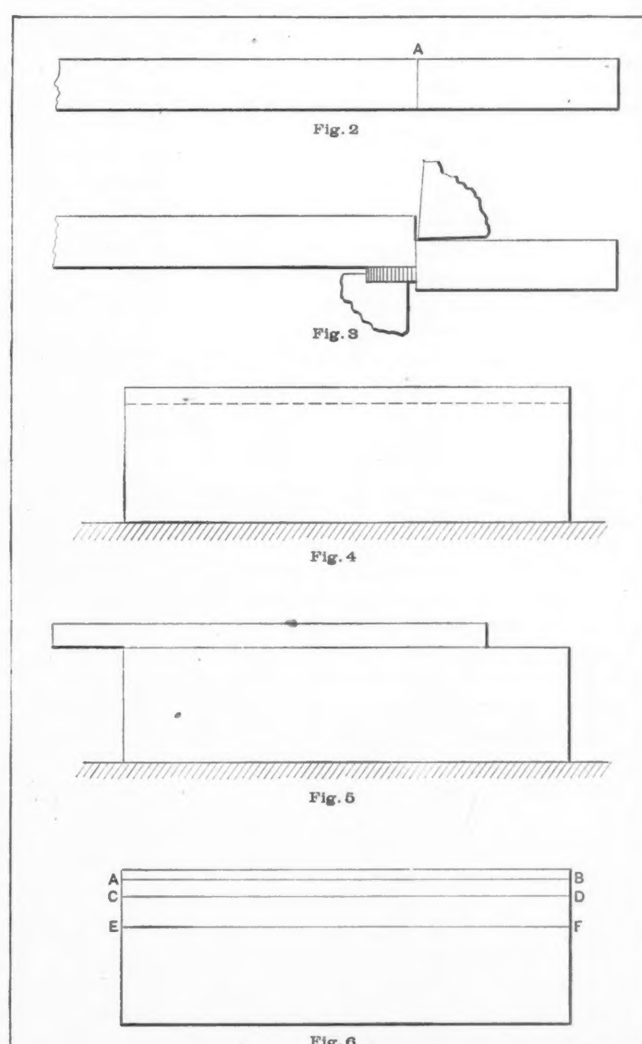
THE articles in MACHINERY on "The Lubrication of Cutting Tools" are of considerable interest. The topic is one of the greatest importance and the material presented has evidently been carefully collected and compiled. While the articles must have been read with interest and profit by many, to me they have been, perhaps, more valuable for the suggestions obtained from them than for the actual information presented.

I have looked in vain, up to the present time, for a satisfactory account of the actual function of a so-called "cutting tool" in the operation of separating chips from the surface of a large body of metal, say steel, as in an engine lathe, especially in connection with modern high-speed practice, and the articles referred to perhaps leave more questions to be answered than there were before.

In any discussion intended to lead to the establishment of conclusions acceptable for practical guidance, nothing is of more importance than that the preliminary assumptions be correct. A false start may not only lead to grievous error, but may lead us farther from the truth we set out to seek. So I will say frankly that at the beginning of the article on "The Lubrication of Cutting Tools" there is one statement that cannot possibly be correct. We are told that the severing of the chips from the body of the metal by the thrust of the cutting tool is essentially a shearing action. Now, how can this be so? Fig. 1, which is reproduced from the article referred to, in the January number of MACHINERY, cannot be said to show any shearing action. The essential characteristic of a shearing operation is the sliding of two surfaces in contact with each other at the time of severance, these surfaces being instantly created at the time that the shearing takes place and by the act of shearing. Say that a bar of metal, Fig. 2, is to be cut at *A* by shearing. The bar is laid upon the lip of a cutting shear, Fig. 3, and as the shearing blade descends the piece is cut off, being slid downward in the manner shown. This, without doubt, will be accepted as a simple and true representation of the shearing operation, and there is nothing analogous to it in the severing of the chip by a cutting tool on the lathe or planer.

Suppose that a heavy chip, as indicated by the dotted line in Fig. 4, is to be taken off a block of metal that is securely fastened upon a planer bed. If the action were that of shearing, the entire slab would have to be shoved off all at once, as in Fig. 5. Certainly nothing suggestive of such an operation occurs in the severing of the chip. We are assuming here, as it does not in any way affect the fact, that the block of metal is stationary and that the tool moves, as in a shaper. It might be suggested that while the shearing does actually take place, as theorized, the shearing and the accompanying sliding of the metal upon itself takes place only for a short distance at a time, immediately in front of the point of the advancing tool. The portion of the chip that is slid along in the act of shearing is more or less crushed or distorted ahead of the actual cut by the pressure of the advancing shearing tool, and then doubles up and scrambles out of the way by the shortest route. But even this assumption does not seem tenable, as there is no swelling of the outer surface of the chip much in advance of the cut, which would be characteristic of the operation if the shearing assumption were correct.

Referring again to the block of metal, the line *AB*, Fig. 6, may represent the line of cleavage for a thin chip or shaving to be taken off the surface, and the line *CD* will represent a much heavier chip. We may assume that the metal of the block is entirely homogeneous, which it practically is in all cases as far as the cutting of it or the making of chips is concerned; consequently, the particles have the same strength of cohesion along the line *CD* as along the line *AB*, and it should take no more force to sever a chip of the metal along the line *CD* than along the line *AB*. Yet we know that the



Figs. 2 to 6. Diagrams illustrating Shearing Action

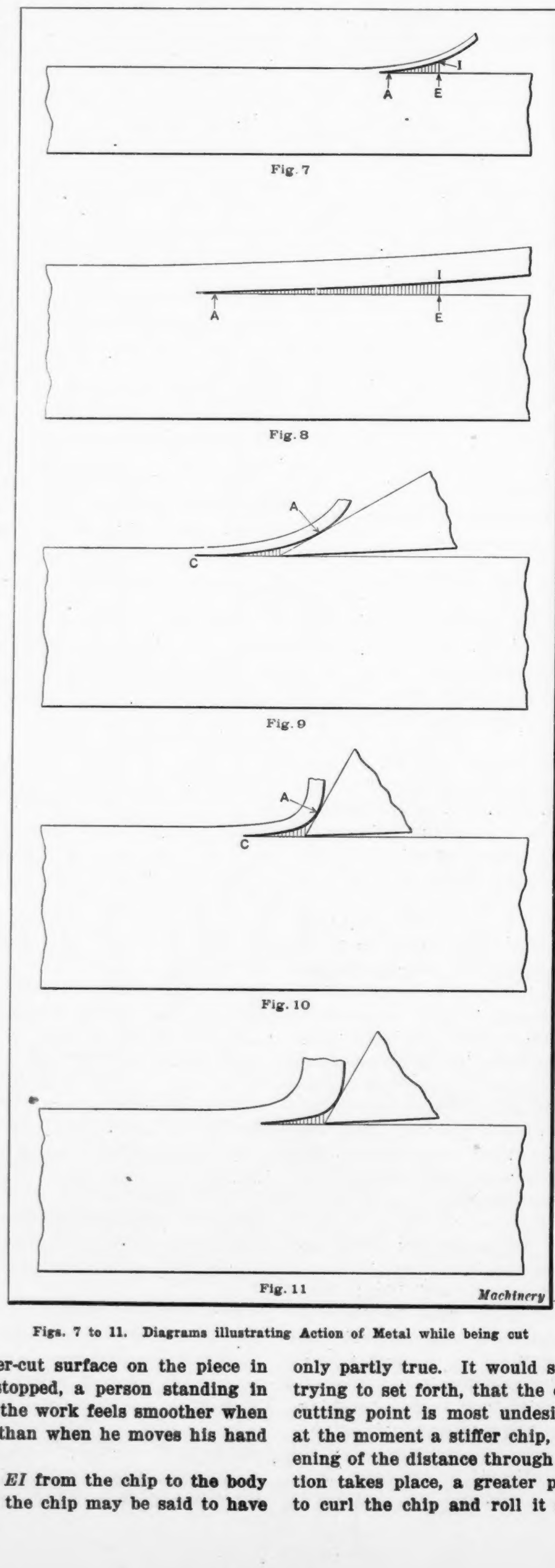
[1]Address: 229 W. 135th St., New York City.

force required is much greater for the thicker chip and that if the chip were still deeper, as at *EF*, it would be impossible to make the cut with any ordinary cutting tool or with the power of any ordinary machine.

Figs. 7 and 8 will show how and why this is so. These sketches are exaggerated to give an idea of what takes place at the innermost point when the actual separating of the metal occurs. The chip is not simply lifted off, nor can it be said to be sheared off, as there is relatively no sliding movement. It must be actually torn off, and a certain space *EI*, Figs. 7 and 8, say 0.0001 inch, may be traversed in tearing before the chip has entirely let go its hold upon the body of metal. The strain of tearing, which is continuous as long as the machine is in motion, may be all the way from *A* to *E* in each case before the chip has entirely pulled away.

Some idea of the ultimate tearing action and the effect of the metal-cutting tool may be had in any machine shop by noticing the surface produced by a fine, broad-nosed tool with a thin water cut on, say, a large steel shaft in the lathe. Although, to the eye, the surface has a beautiful finish, it will feel very different from a surface that has been polished by emery or other abrasive. If the palm of the hand is moved over a polished surface, it feels perfectly smooth, but if the hand is moved over the water-cut surface, a certain roughness is perceptible — a suggestion of minutely projecting prickly points. These are the summits of the microscopically ragged peaks left in the process of tearing the metal away. In addition, if the palm of the hand is moved lightly around the water-finished shaft, first in the direction in which the cutting tool has gone and then in the reverse direction, the surface will feel as if it is serrated or saw-toothed. But the most curious thing is that the roughness will be found to be in the opposite direction to what we might expect. It would seem that if there were any difference, the surface would feel smoother when going over it in the direction in which the tool has passed and that the invisible saw-teeth would face that way. But the fact is that they face in the other direction. With the water-cut surface on the piece in the lathe and with the lathe stopped, a person standing in front of the lathe will find that the work feels smoother when he draws his hand toward him than when he moves his hand toward the back of the lathe.

In Figs. 7 and 8, the distance *EI* from the chip to the body of the metal at the point where the chip may be said to have entirely let go its hold is assumed to be the same in each case. Say that the tearing away begins at *A* and is completed at *E*; then for the entire distance from *A* to *E* in each case great force is required to do the tearing. As the chip in Fig. 7 is thin, it curls away more quickly, or with a shorter radius, than the thicker chip in Fig. 8. Consequently, the distance *AE* in Fig. 8, through which the force is continuously applied to do the tearing, is more than double the distance from *A* to *E* in Fig. 7, and more than double the force will be required at any instant to tear away a continuous chip.



Figs. 7 to 11. Diagrams illustrating Action of Metal while being cut

In the present discussion, it is the heavier chips in which we are most interested. The heavy chip requires greater force because of the slowness with which the thick chip curls away before the advancing tool. The inevitable suggestion follows that to reduce the power requirement we should shorten the tearing away period by curling the chip with a quicker or sharper curvature. Of course, if the chip were very hot, it would bend more sharply, so that the heat of the chip is to be regarded not as incidental but as a most essential condition of high-speed practice. The hot chip necessarily requires for its production high-speed steel, the essential characteristic of which is its ability to retain a sufficient hardness at a high temperature. The hot chip is the most essential condition, and a tool steel that is hard while hot is the thing which makes it possible. It is proper to note here that the new non-ferrous alloy stellite possesses the property of cutting-hardness while hot to a degree far beyond that of any of the hitherto known high-speed tool steels. In competition with the latter, in munition factories in France, much higher speeds have been found possible with an increased output of 50 per cent or more.

It will not do to let the heating of the tool and chip go on unchecked. The local heating of the chip for high-speed work is essential at the instant before the tearing away of the chip, and immediately after that the heat generated must be gotten rid of as best it may. The article referred to says that the most important function of the so-called "lubricant" is to secure the cooling effect. This is only partly true. It would seem, from the view we are here trying to set forth, that the cooling of the chip at the actual cutting point is most undesirable, because that would mean at the moment a stiffer chip, a slower curling away, a lengthening of the distance through which the actual severing operation takes place, a greater pressure on the nose of the tool to curl the chip and roll it away, and a greater power con-

sumption for driving. This is corroborated by the experience of Mr. Taylor, if rightly interpreted. We are told that Mr. Taylor found that a heavy stream of water poured on the chip when it is removed from the steel forging would permit of employing a higher cutting speed, thus increasing the rate of production from 30 to 40 per cent. This might have been expressed in quite a different way. When the chip is so cooled that it is not so flexible and so that, on account of the slower curling of the chip away from the work, the nose of the tool cannot approach so closely to the rupture zone, it is not only permissible, but also absolutely necessary to increase the running speed so as to raise the temperature of the chip again to the point at which it will bend easily, thus reducing the force required per unit of surface traversed.

While the cooling of the chip at the precise point where the initial curling occurs is to be avoided as much as possible, the cooling of the tool at the same point is imperative for the purpose of maintaining the temper, or the necessary hardness, to enable it to stand up under the working pressure. With a speed sufficient to heat the chip at the instant of its curling away, in spite of the flood of lubricant, the simultaneous cooling of the tool is necessary, and the temperature of the body of the work will not be affected sufficiently to require much consideration, especially as such a cut as we here have in mind is not to be regarded as a finishing cut that requires great accuracy. That heat is generated when metal is forcibly torn away is shown by the abrasive grinding wheel. When the particles of metal are successively severed, they come away white-hot. They are so heated, in fact, that they are actually burning, as is shown by the scintillations. So we may suppose that, notwithstanding the flooding of the chip with the cooling liquid, it may be hotter at the critical instant of rupture than we realize from its appearance.

We are aware that the action and reaction of tool and chip, and the heating of both in the cutting operation, is by no means as simple as we have assumed. The heating, we may believe, is not due to the tearing of the metal, but to the friction and compression by which the process is accomplished. The resistance that the cutting tool opposes is not concentrated at the extreme cutting edge—the apex of the angle—but most of it comes on the beveled face back of the cutting edge. For instance, in Figs. 9 and 10, the greater stress comes on the surface of the tool at *A*, where most of the actual work of the tool is done, and the necessity of lubricating and cooling the tool at this point must be self-evident.

Figs. 9 and 10 illustrate the difference in chip-curling effect that may result from differences in the cutting angle of the tool. If the work of the tool is thought of as actual cutting, like the cutting of wood, an acute angle as in Fig. 9 will be favored, but experience shows that an angle even more obtuse than that in Fig. 10 will be more successful. In Fig. 9, the chip curls away more slowly, or with a greater radius than in Fig. 10, and the distance *AC* through which the ultimate tearing apart of the metal continues is greater, which means that a greater force is required to do the tearing.

The heating of the tool and the chip is not to be wondered at when the tool pressure and the rapidity of flow of the chip at *A* are taken into consideration; but another important condition adds largely to the heating effect. This is the rapid compression of the chip under the pressure of the tool and the necessary distortion of the metal in curling. As this curling is accomplished entirely by pressure on the outside of the curve, the inevitable result is the thickening of the flowing chip, as suggested by Fig. 11. Perhaps the best idea of the actual thickening or upsetting of the chip is to be had by standing in front of a lathe in motion and noting the slowness of the chip movement as compared with the circumferential speed of the piece from which the chip is being peeled.

It might be remarked in criticism of the preceding that we have left little or nothing for the sharp edge—the extreme apex of the cutting angle of the tool—to do. That it has comparatively little of the heavy work to do is shown by the condition of a tool after, say, an hour of heavy, high-speed cutting. This "cutting edge" may not really have much to do with the actual severing of the chip from the body of the piece, but it still has its necessary share of the work in shaving off the minute projections of the surface left after the tearing away of the chip.

* * *

CADILLAC MOTOR CAR CO.'S NEW EMPLOYMENT POLICY

The Cadillac Motor Car Co., Detroit, Mich., has issued the accompanying announcement of an important new policy, to all its employes, which doubtless will be adopted by many other manufacturers. It should work no hardship on any person of foreign birth who intends to make this country his home. The policy is in line with that which requires employes of foreign birth to learn to speak and read the English language in order to be promoted. One large western manufacturer has for a long time made it conditional to advancement that its foreign born employes learn to speak and write English; they thereby become acquainted with American institutions and are more worthy of trust and responsibility.

AMERICANS FIRST

The Cadillac Motor Car Company makes this announcement of a new and important policy to all its employes:

FROM and after this date promotions to positions of importance in the organization of this Company will be given only to those who are native born or naturalized citizens of the United States, or to those of foreign birth who have relinquished their foreign citizenship, and who have filed with our Government their first papers applying for citizenship, which application for citizenship must be diligently followed to completion.

Employes of foreign birth who retain their foreign citizenship will not be discriminated against in their present positions or work, but they will not be promoted to positions of responsibility and trust.

A pre-requisite to employment by this Company must be loyalty to our Government and our flag, in addition to loyalty to the Company itself.

All department leaders are authorized to make this order effective immediately.

Cadillac Motor Car Company

Detroit, Michigan
March 23, 1917

* * *

PROPOSAL FOR METRIC SYSTEM IN GREAT BRITAIN

According to the *Railway Review*, the Associated Chambers of Commerce, an organization of British business houses, has drafted a bill which is designed to establish the metric system as a standard of measurement in Great Britain. This bill is now being circulated throughout the country for consideration and criticism. It appears that a considerable part of the opposition to the metric standard originated in the fear on the part of some British manufacturers that the compulsory adoption of the metric system will necessarily involve the immediate scrapping of all their existing machines, patterns, tools and other workshop standards. Such a thing has not happened in any other country which has adopted the metric system, but those who drafted the proposed bill have incorporated provisions which are designed to overcome objections of this kind. A clause is inserted, therefore, which covers the situation in the following language: "Provided that nothing in this act shall affect the manufacture or use of any machinery, tool, pattern, sieve, templet, or other article made by measures other than metric measures." The passage of an act so worded would thus mean that while it would be required to buy and sell goods to metric standards, the existing weights and measures could be used for manufacturing purposes until it became more convenient to change them.

GRIDLEY MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINES—1

DESIGN, CONSTRUCTION, OPERATION, TOOL EQUIPMENT AND ATTACHMENTS

BY DOUGLAS T. HAMILTON[2]

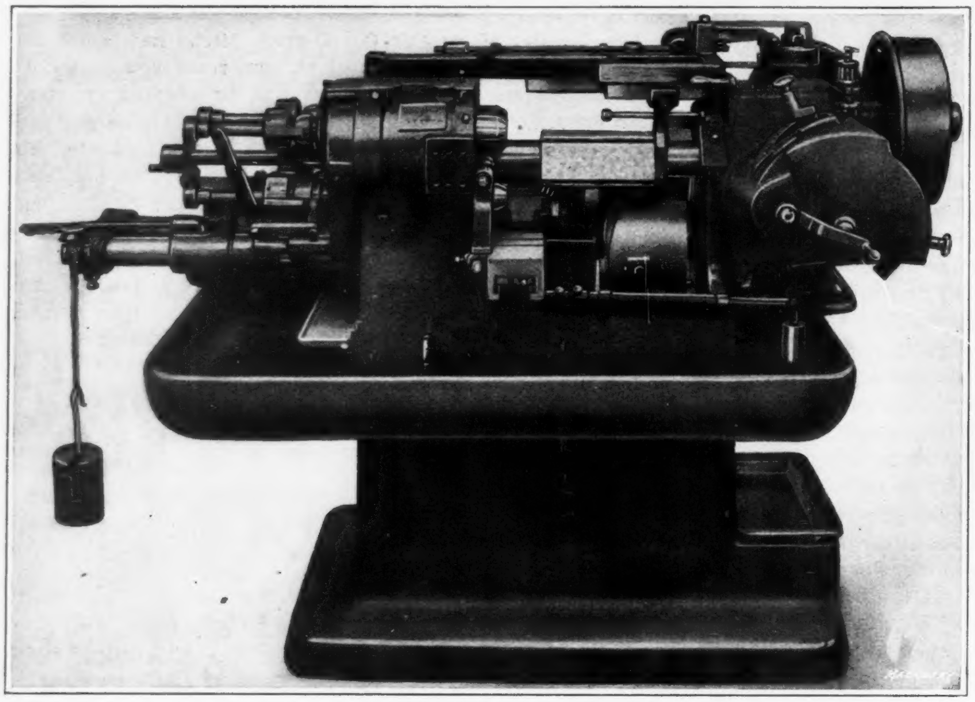


Fig. 1. Front View of Gridley Multiple-spindle Automatic Screw Machine

THE Gridley multiple-spindle automatic screw machine, the first size of which was designed and built in 1908 by George O. Gridley, was constructed around the turret principle originated in the single-spindle machine described in the May number of MACHINERY. There are, however, certain modifications in the multiple-spindle machine that adapt it for handling more than one bar at a time. The turret design differs in that, instead of having independent tool-slides moving in a longitudinal direction, the entire turret moves longitudinally, bringing the various end-working tools into operation on the work. There are other important differences in this machine, which will be dealt with in the following.

Principle of Design

The chief feature in the design of the Gridley multiple-spindle automatics is the spindle carrier, and the mounting of the tool-slide on it, which does not necessitate any overhanging of the turret tools, and consequently enables the machine to stand up under heavy cuts and coarse feeds without perceptible chatter. In construction, this machine comprises four work-spindles, which are held in a spindle carrier; these spindles are rotated by spur gears from a central gear on the shaft that runs the entire length of the machine and passes completely through the spindle carrier. The spindle carrier is indexed to bring the bars successively into line with the various tools on the turret slide, by means of a Geneva stop mechanism, which will be described in detail later.

One of the most important features of this machine is the relation of the turret slide to the spindle carrier. While the turret slide proper does not rotate with the spindle carrier, the latter, in addition to rotating in the casing, also rotates within the turret slide. In other words, the end of the spindle carrier forms a shaft or bearing on which the tool-slide is supported. This insures that the spindle carrier and turret slide will always be in perfect alignment.

The turret slide has four standard tool positions; these, instead of being located on the flat faces of the turret, are located on the four corners, which are machined to provide a narrow base and also to form a T-slot for clamping the tools in position. Thus the turret tool-holders, instead of fitting on a flat face, fit on two angular surfaces, forming an included angle of 90 degrees. It is therefore possible to get more accurate alignment of the turret tools with the spindle than it would be with a T-slot alone, and as all of the turret tool-holders are bored out in position on the machine, accurate alignment between the tool-holders and spindles is easily secured.

Reference to Figs. 1 and 2 will show that the turret slide, in addition to being rigidly supported on the extended end of the spindle carrier, is guided by an arm that moves on a top guide, fastened to a bracket extending from the spindle end to the power end of the machine. Like the single-spindle machine, this machine has one main cam-shaft carrying drums for advancing and returning the turret slide, indexing the spindle carrier, etc. The cross-slides, however, are operated by a separate cam-shaft located at right angles to the first one, and driven from it by bevel gears, as will be described subsequently.

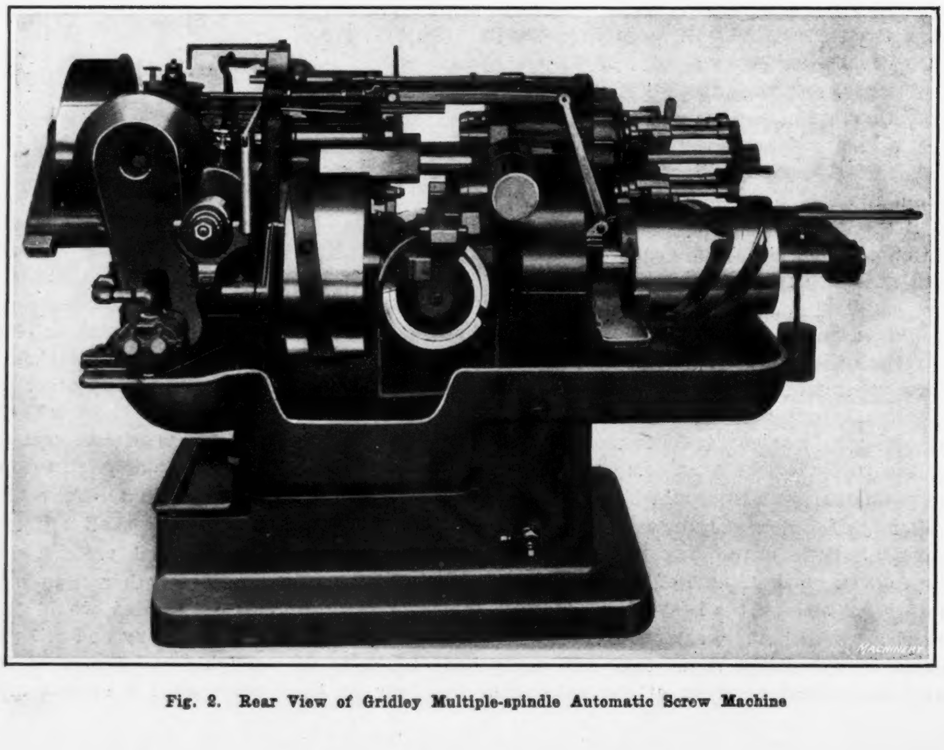


Fig. 2. Rear View of Gridley Multiple-spindle Automatic Screw Machine

[1] For other articles on automatic screw machine practice, see "Gridley Automatic Turret Lathe," in the May, 1917, number, and articles there referred to.

[2] Address: Fellows Gear Shaper Co., Springfield, Vt.

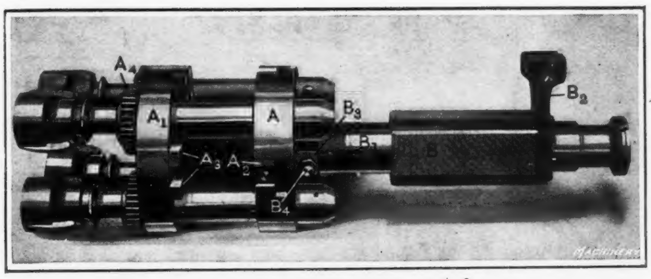


Fig. 3. View showing Spindle Carrier and Turret Slide removed from Machine

As all the turret tools are at work on different bars at the same time, it is obvious that the time required to produce one piece is only that necessary for performing the longest single operation plus the time required for moving the turret slide away from the work, revolving the spindle carrier one-quarter revolution, and moving the turret slide forward again to bring the tools into the cutting position. There are cases, however, where the longest single operation is accomplished from the cross-slide, and in this case, of course, the time required for the cutting-off or forming operations plus the idle movements just mentioned would be the total time to make one piece. With a separate arrangement of stops, as will be described later, it is possible to use all four faces of the turret for carrying end-working tools, and the turret is so designed that one tool can be placed behind the other on the same corner for performing operations on long work or for doing drilling and turning operations at the same time. This is obviously an advantage where a considerable number of operations are necessary to complete the part being made. The turret, of course, is not indexed, but is simply moved back and forth to bring the tools into and out of contact with the work. The spindle carrier is indexed one-quarter revolution for each advance of the turret slide, a piece being finished and cut off at each advance of the slide.

Spindle Carrier and Turret Slide

The spindle carrier and turret slide are shown removed from the machine in Fig. 3, where it will be noticed that these two members are tied together. The spindle carrier, as has been previously mentioned, consists of a drum provided with bearings A and A_1 and an extended central part on which is mounted the tool-slide. Bearing A carries hardened and ground blocks A_2, in which the locking pin enters for locating the spindle carrier in line with the various tools on the turret slide; whereas bearing A_1 is provided with hardened and ground guide blocks A_3, in which the roll in connection with the Geneva stop mechanism enters for indexing the spindle carrier one-quarter revolution. These two bearings, as has been previously mentioned, rotate inside a casing, and carry the four work-spindles, which are driven by gears A_4 from a central shaft A_5, Fig. 6, as will be described later. On each spindle is a gear that meshes with the central gear, and rotates continuously.

The turret slide proper B, Fig. 3, moves back and forth on the extended part of the spindle carrier B_1. The turret B is of square section and is provided with T-slots at its four corners for clamping the turret tools in position. Fastened to the rear end of the turret is a bracket B_2 that is used to guide the turret in correct alignment with the axis of the spindle, this arm being controlled in its position by a guide fastened to the overhead bracket running from the feed end to the spindle end of the machine. The spindle carrier also carries a spider B_3 having four adjusting screws, and lock-nuts B_4, which control the forward movement of the forming slide when it is desired to form to unusually accurate diameters.

Construction of Work-spindles

The work-spindles, as shown in the sectional view in Fig. 4, comprise a steel sleeve C that extends through the work-spindle carrier and is supported in long phosphor-bronze bearings C_1 extending the full length of the carrier. These bearings are keyed to the spindle carrier and are provided with liberal oil-grooves. A sleeve C_2 surrounds the bearings C_1, fitting closely between the cheeks or bearing surfaces of the spindle carrier, and acts as an oil reservoir for the spindle bearings. The front end of spindle C is threaded and the nose cap C_3 is screwed on; this nose cap is of the type which closes the chuck when the latter is forced into it. Located between the shoulders on spindle C and bearing C_1 is a steel and phosphor-

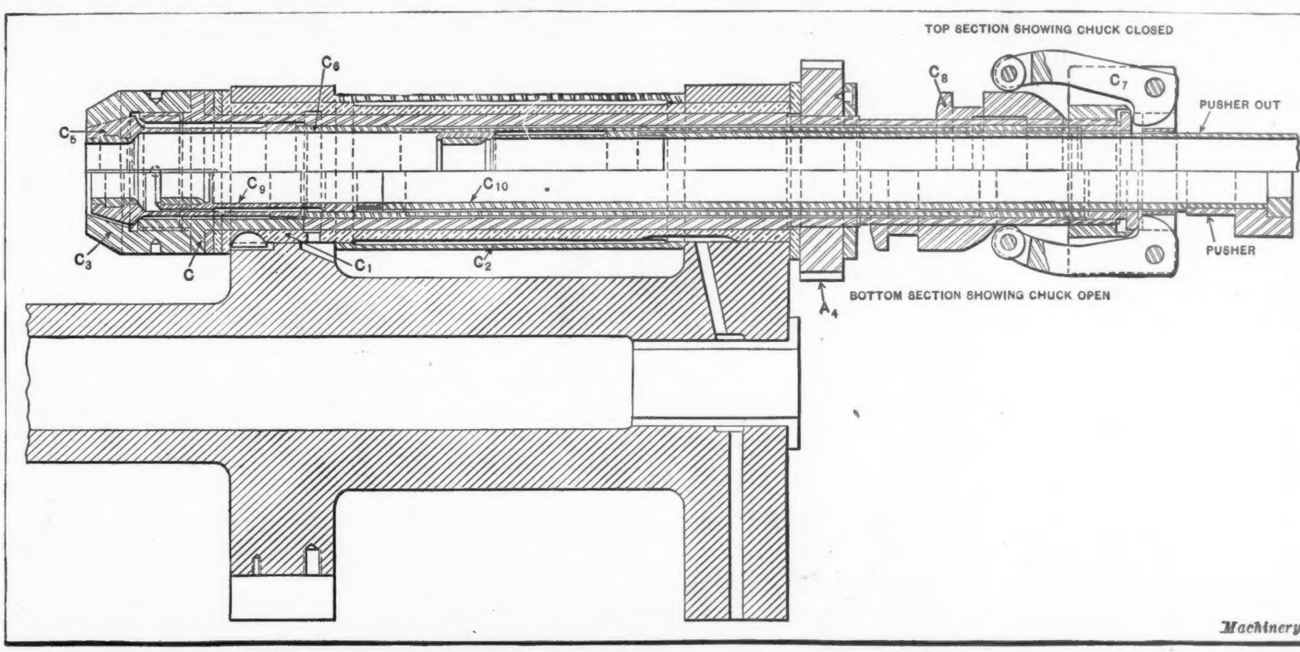


Fig. 4. Section through Work-spindle, showing Chuck-closing and Stock-feeding Mechanism. Note that Stock-feeding and Chuck-closing Mechanisms are shown in Forward and Rear Positions—Upper Section shows Chuck closed and Feed Pusher withdrawn, and Lower Section shows Chuck Open and Feed Pusher advanced

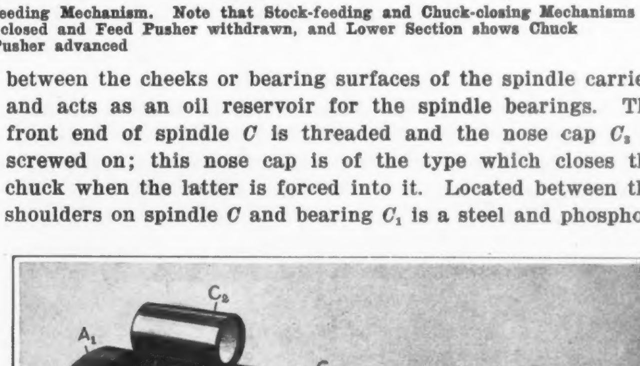


Fig. 5. Detailed View of Spindle Carrier, showing Bearings and Oil Retaining Sleeve removed

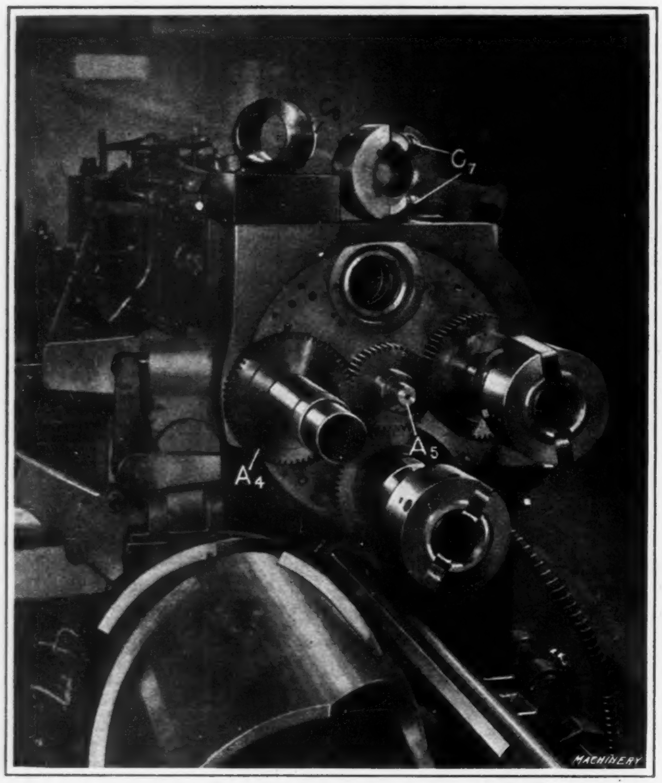


Fig. 6. Dismantled View of Cylinder, showing Driving Gears for Work-spindle

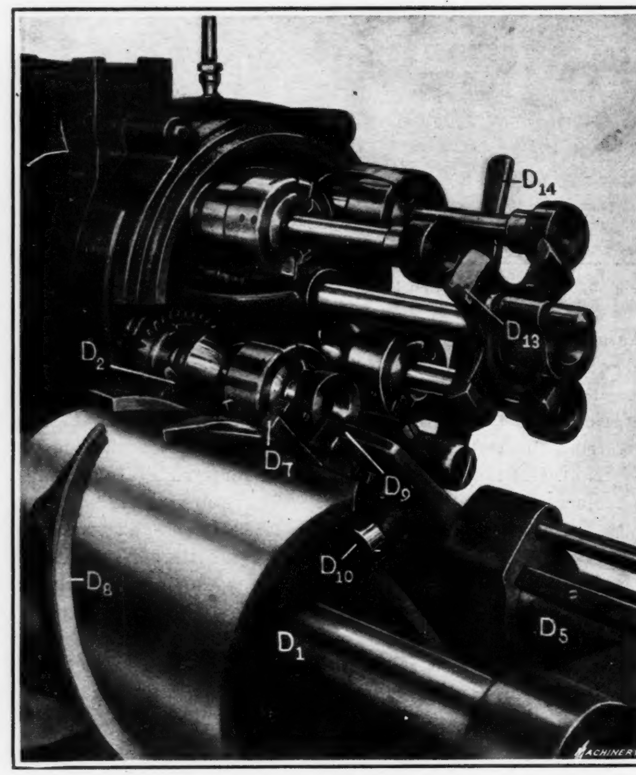


Fig. 7. End View of Machine, showing Chuck-closing and Stock-feeding Mechanism

bronze ring that takes the end thrust. The rear end of the spindle carries the driving gear A_4, which is keyed to the spindle. Between bearing C_1 and gear A_4 is a bronze thrust washer. The construction of the spindle bearings is more clearly illustrated in Fig. 5, where one of the bearings is shown ready to be inserted.

The spring collet C_5, Fig. 4, which is of the push type, carries bushings as illustrated, except on the ¾-inch size, so that one collet can be used for several different diameters of stock. This collet is closed on the work by being forced into the nose cap C_3 by a sleeve C_6 that extends through the work-spindle and has a collar on its rear end against which the short arm of closing fingers C_7 contacts. These closing fingers are carried in a collar that is attached to the rear end of the work-spindle and have rollers on their long arms which contact with the spool C_8 that is moved back and forth for opening and closing the chuck.

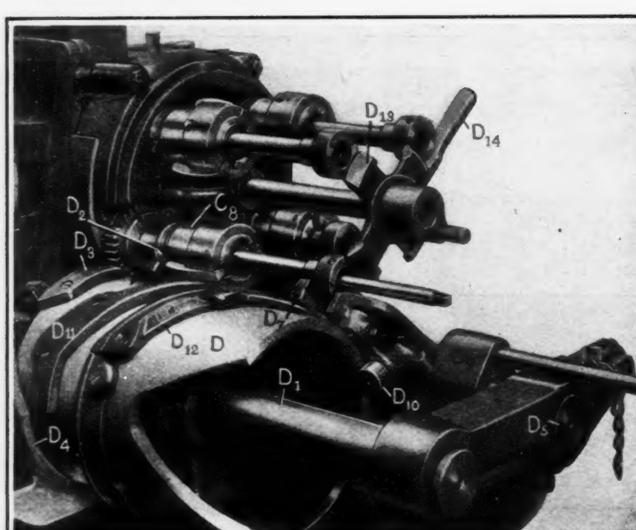


Fig. 8. End View of Machine, showing Feed Pusher withdrawn

The stock is fed forward by means of a feeding finger or pusher C_9 which is provided with bushings on the larger sizes of machines. This is screwed into a pusher sleeve C_{10} that passes completely

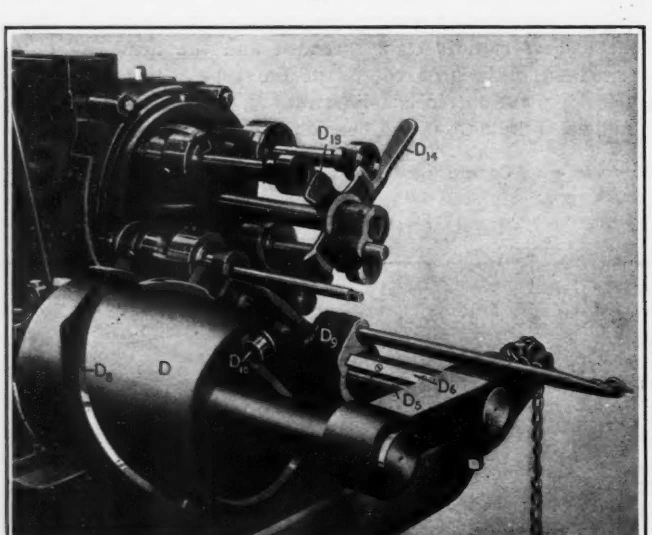


Fig. 9. End View of Machine, showing Feed Pusher advanced

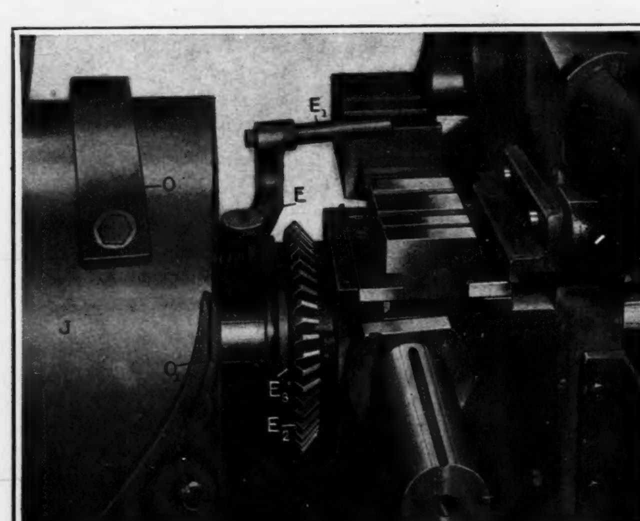


Fig. 10. Swinging Stop for gaging Stock to Length

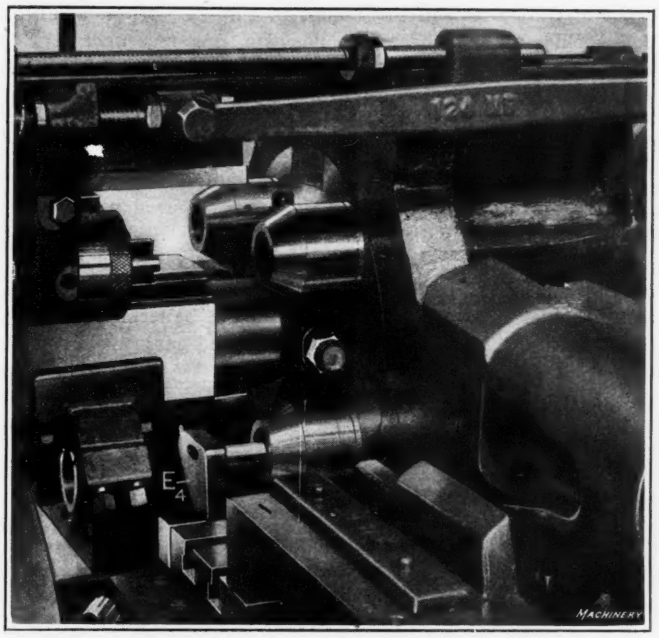


Fig. 11. Type of Stop used when a Tool is in Fourth Position on Turret Slide

through the spindle of the machine; it is withdrawn by a cam on the drum located at the left-hand end of the machine, and is advanced by a weight and cam follower.

Chuck-closing Mechanism

As has been previously mentioned, the collet or chuck is closed by means of a sliding sleeve that receives motion from fingers held in a collar attached to the rear end of the spindle. These fingers, in turn, are operated upon by a spool C_8, which is free to slide on the spindle proper. The forward end of the

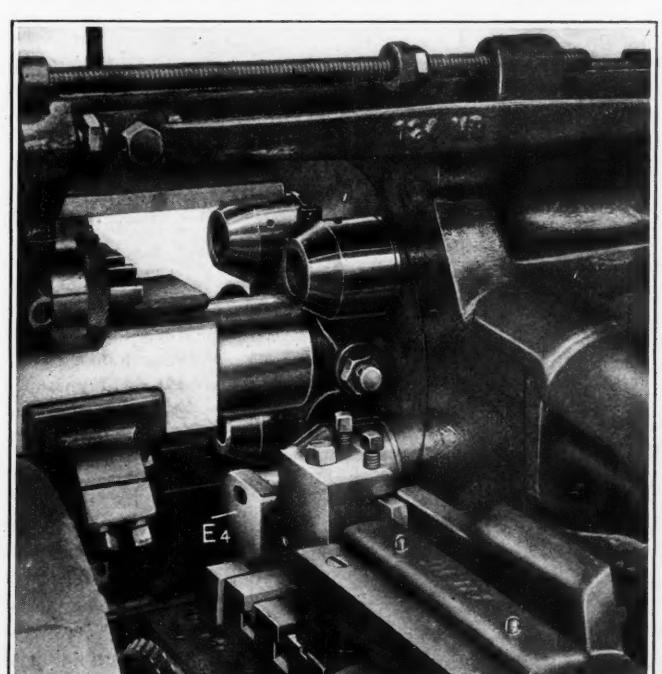


Fig. 12. Stop shown in Fig. 11 in Position when Cut-off Slide is advanced

spool has a groove in it in which a forked lever D_2, Fig. 7, fits when the cylinder head indexes the spindle around to the fourth or stock-feeding position. A drum cam D, Fig. 8, held on the main cam-shaft D_1, carries cams for operating forked lever D_2, cam D_4 acting to force spool C_8 under the chuck-closing fingers, and cam D_{11} withdrawing it. Lever D_2 is retained on shaft D_5, which has a key D_6, Fig. 9, extending its entire length, so that the fork can slide back and forth, but cannot rotate. When the spool is removed from beneath the finger rolls, the latter collapse and allow the chuck-closing sleeve to be forced back by the spring temper in the chuck, thus opening it and allowing the work to be fed forward. When setting up the machine the chuck can be operated by hand-lever D_{14}.

Operation of Stock-feeding Mechanism

The stock-feeding mechanism, as has been previously described, consists of a feeding finger or pusher attached to a tube. This tube, as shown in the sectional view Fig. 4, extends completely through the spindle of the machine and at the rear end is provided with a collar against which the operating arms work. As shown in Figs. 7 and 9, two arms are required for operating the stock pusher. Both these arms are held on shaft D_5, being free to slide upon it but prevented from turning by the key D_6. Arm D_7, which is used for withdrawing, is operated by cam D_8 on drum D, this arm carrying a roll

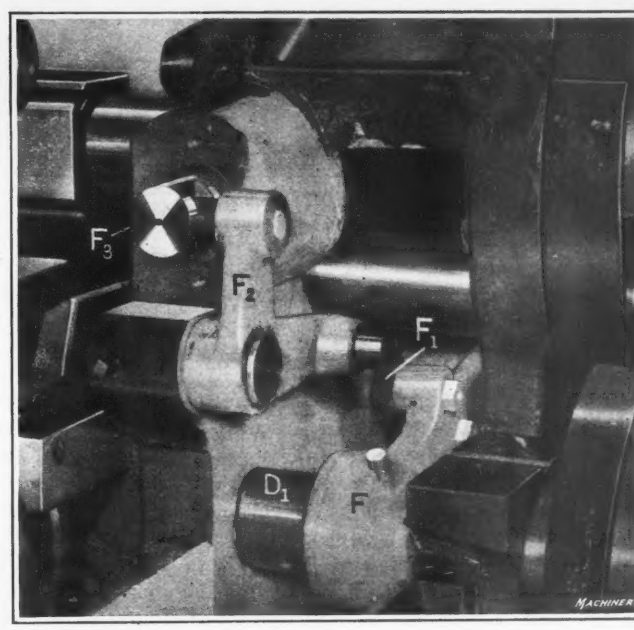


Fig. 13. Detailed View, showing Geneva Stop Mechanism for indexing Spindle Carrier. View shows Position of Arm just after indexing

that contacts with the cam face. Arm D_9, which also carries a roll D_{10}, is used for forcing the pusher forward to advance the stock, the roll being kept in contact with the cam face on the rear end of drum D by a weight. As previously mentioned, the weight is depended upon to advance the stock. Drum D also carries safety cams D_{11} and D_{12}, Fig. 8, for the chuck-closing and stock-withdrawing arms, respectively. In order to prevent the stock pushers from gradually working out of the spindles when the bar becomes short, a star D_{13}

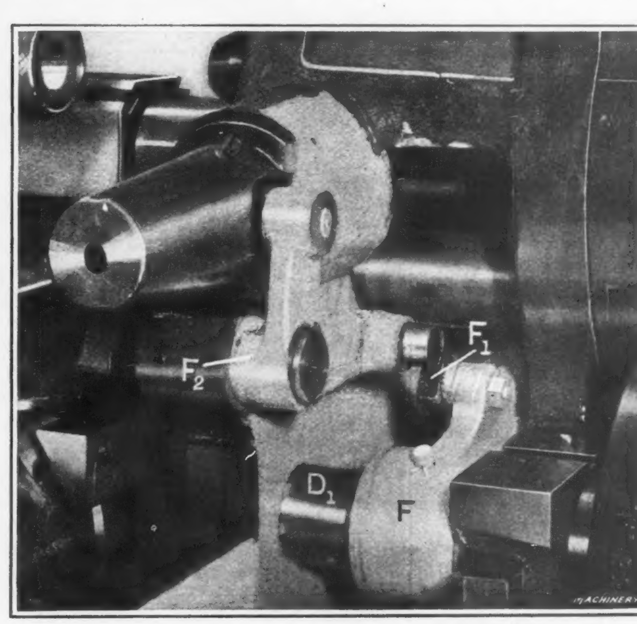


Fig. 14. Another View of Spindle-carrier Indexing Mechanism, showing Guard over Locking Bolt for retaining Spring

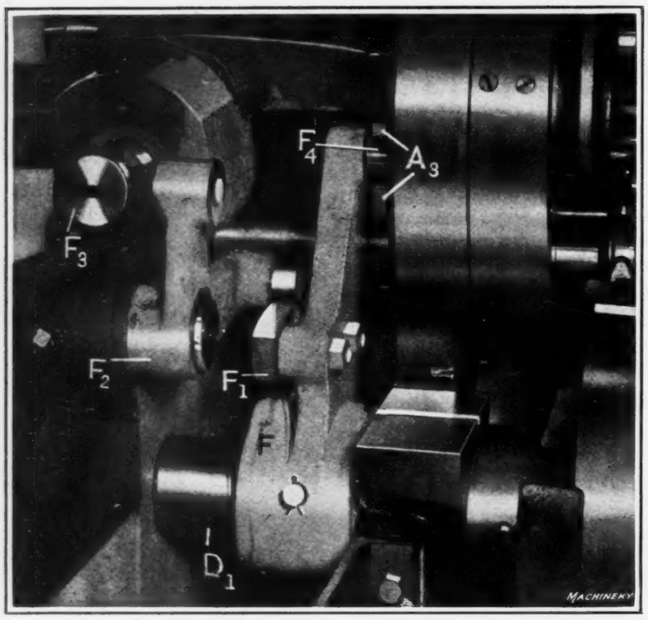


Fig. 15. View showing Indexing Arm about to index Spindle Carrier with Locking Pin withdrawn

having four arms is used as a back stop; when it is desired to remove the stock pushers, this is done by simply taking out a plug and swinging the star stop around.

Operation of Stock Stops

As has been previously mentioned, the feeding of the stock on the Gridley automatics is carried on in the fourth position, and a stop controls the distance the stock is fed out, as shown in Fig. 10. This stop consists of a bellcrank arm E fulcrumed on a post and carrying an adjustable stop proper E_1. The other end of this lever is provided with a cam surface, which is kept in contact, by a spring, with the rear face of the bevel gear E_2 that is used for driving the cross-slide drum. On the rear face of the gear is a cam projection E_3 which swings the stop E into the feeding position when the stock is about to be fed forward.

When it is desired to use an end-working tool in the fourth position, which is interfered with by the stop, a special stop E_4 held on the cut-off slide, as shown in Figs. 11 and 12, is used. This stop is fastened to the front face of the cut-off slide and consists of a bracket having one arm that extends in front of the chuck. When it is desired to use a drill, reamer or other tool in the fourth position, a hole is drilled through the stop bracket, which is elongated so that the tool can pass through the stop and operate on the work. The necessity, of course, for elongating the hole is to allow for the backward and forward movement of the cut-off slide. This particular stop is shown in the position it occupies in front of the cutting-off tool-holder in Fig. 12. When using an end-working tool in the fourth position, it is also necessary to change the cams on the turret slide drum, as will be described subsequently.

Indexing and Locking Mechanism for Spindle Carrier

The mechanism for indexing the spindle carrier is constructed on the principle of the Geneva stop mechanism. This is illustrated clearly in Figs. 13, 14 and 15. Shaft D_1, which carries the drum for operating the chuck-closing and stock-feeding mechanism, has an arm F pinned to it, as shown. This lever carries a cam F_1, which, through a bellcrank lever F_2, fulcrumed to the frame of the machine and carrying a roll on each arm, withdraws the locking pin F_3. As shown in Fig. 14, this locking pin is enclosed inside a cap, and a heavy coiled spring keeps the locking pin forward when not acted upon by the bellcrank lever.

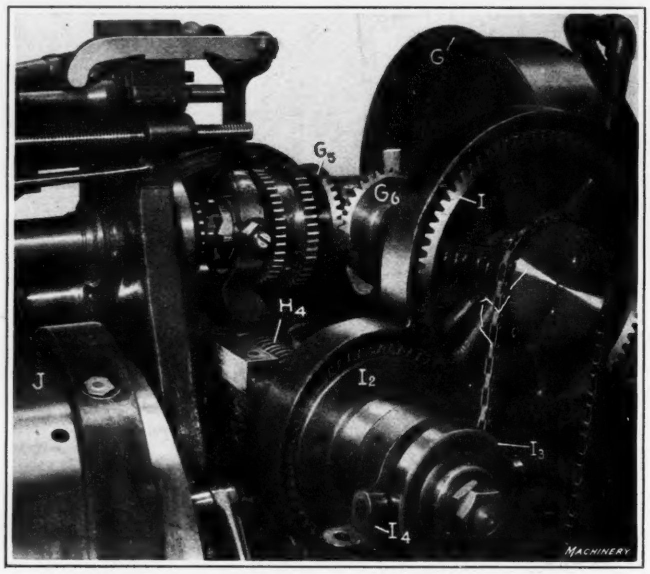


Fig. 16. Partially Dismantled View of ¾-inch Machine, showing Power-feed Mechanism. Note that No Idler Gear is used on Fast-speed Mechanism

The revolving of the spindle carrier is accomplished by lever F which, on its upper end, carries a roll F_4 that enters between the two guide blocks A_3 fastened to the faces of the spindle carrier, as previously described in connection with Fig. 3. This mechanism is so set that the roll on lever F enters between the guide blocks at the precise moment that the locking pin is removed from the spindle carrier. The indexing movement is gradually increased near the center and decreases as it leaves the center, so that there is no jar either in starting or stopping. It is also positive and accurate. The indexing is done on fast speed.

Fig. 17. View showing Operator putting Change-gears into Place

Fig. 19. Operator shifting Position of Gears in Change-gear Box

Operation of Main Cam-shaft, Turret Slide, Work-spindles, Threading Spindle, and Forming and Cutting-off Slides

Power for operating the various mechanisms of the Gridley multiple-spindle automatic for the belt-driven type of machine is secured through a pulley G and two change-gears G_1 and G_2, as shown in Figs. 16 and 17; in Fig. 17 the operator is putting the change-gears into place. To remove these two gears it is necessary to release the clamping screw on arm G_3, pull it around, drop it out of the way, and then remove the pulley. The changing of these gears directly affects the spindle speed and, during the slow or working movements, the speed of the cam-shaft, although this member is subject to a separate control by a change-gear box.

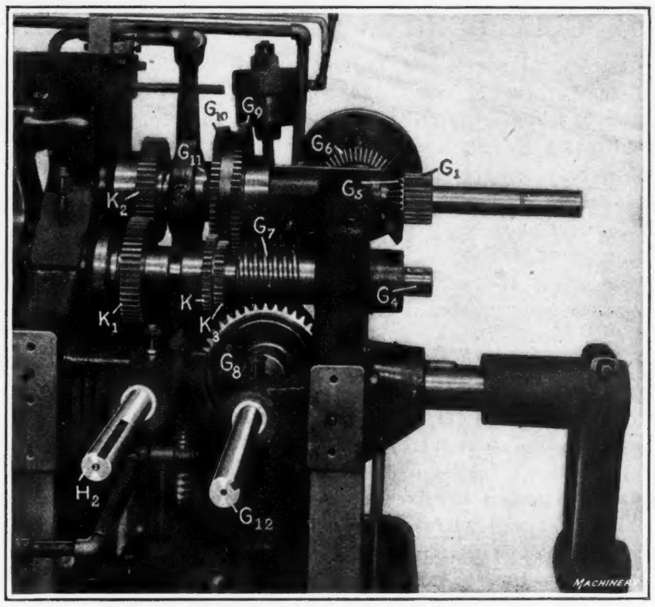


Fig. 18. Partially Dismantled View, showing Gear Drive for Main Cam-shaft, Work-spindle and Threading Mechanism

The gear G_1 on the pulley shaft drives change-gear G_2 on shaft G_4, Fig. 18. The pulley shaft also carries a bevel pinion G_5, which drives the pinion G_6 that controls the fast and slow speed movements, to be described later. Gear G_2 is directly located on the spindle drive-shaft G_4, which carries a worm G_7 meshing with worm-wheel G_8 on the feed-gear-box shaft. The shaft that carries gear G_1 also carries twin threading gears G_9 and G_{10} and a clutch G_{11}. Shaft G_4 extends through the axis of the spindle carrier and drives the work-spindle.

The gear-box shaft G_{12} has a keyway in it, as shown, and a gear (not shown) supported by bracket G_{16}, Fig. 19, slides on this shaft. This bracket also carries an idler gear G_{15}, which is constantly in mesh with the gear on the gear-box shaft. Bracket G_{13}, to which lever H_1 is attached, carries three gears G_{14}, and worm-shaft H_2 carries a cluster of six gears H_3 and a ratchet and pawl, not shown. This shaft continues through the machine, and, as shown in Fig. 20, carries a worm H_4 for driving the worm-wheel H_5 that rotates the main cam-shaft J. The three gears on arm G_{13}, Fig. 19, and the six gears on worm-shaft H_2, provide eighteen changes of speed for the main cam-shaft, irrespective of the speed of shaft G_4, Fig. 18. These speed changes are effected by manipulating levers H and H_1. Gear G_{15} is meshed with any of the three gears G_{14}, and the largest of the three gears G_{14} is meshed with any of the six gears H_3.

The functions of the two levers H and H_1, while both controlling the speed of the main cam-shaft, during its slow or working time, differ in that lever H provides for the use of the three separate cams on the turret slide drum. The various sizes of machines are provided with three cams, giving leads in a constant ratio; for example, on the 3/4-inch size, the cams give leads of 1 1/2, 3 and 4 9/16 inches. These cams, of course, cover the same section of the circumference of the cam drum, but the 3-inch cam advances the turret slide twice as far as the 1 1/2-inch cam in the same arc of rotation of the cam drum. The throw of the cam, and the speed at which it is rotated, controls the feed of the turret slide in relation to the speed of the work, so that by changing the levers previously referred to, the feed is varied. This change can be made while the machine is in operation.

The idle movements of the machine are operated at a faster speed than that at which the cam-shaft rotates when the tools are cutting. This is accomplished by a separate driving mechanism, Fig. 20. Miter gear G_5 on the pulley shaft drives G_6. The shaft carrying gear G_6 extends to the rear of the machine and carries a gear I, which through an idler I_1 drives gear I_2 on the worm-shaft. This shaft carries the Johnson clutch I_3, which can be operated by hand-lever I_4 or by dogs held on turret drum J. The high-speed dog is set at the high point of the lead cam, and the slow-speed dog is adjusted in the key-slot in cam drum J, so that the drum runs at high speed. Now when the Johnson clutch is brought into engagement with the fast speed gears, it drives the worm-shaft so fast that this shaft runs away from the pawl on the outer end of shaft H_2, Fig. 19. Gears I, I_1 and I_2 then drive the cam-shaft at high speed to take care of the idle movements.

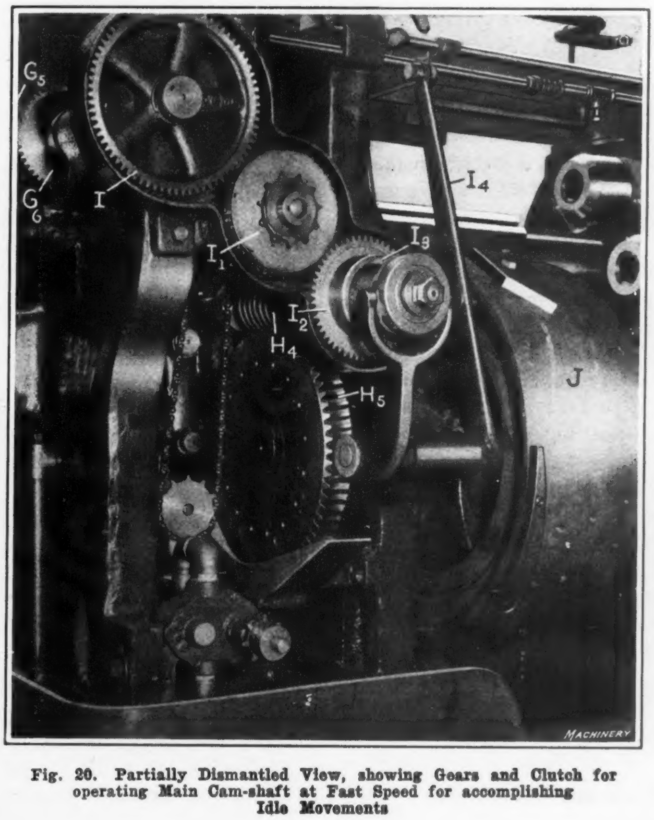


Fig. 20. Partially Dismantled View, showing Gears and Clutch for operating Main Cam-shaft at Fast Speed for accomplishing Idle Movements

MACHINERY

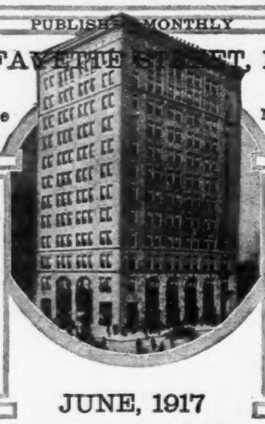
DESIGN — CONSTRUCTION — OPERATION

PUBLISHED MONTHLY

140-148 LAFAYETTE STREET, NEW YORK

England
51-52 Chancery Lane
London

Cable Addresses
Machinery, New York
Machtool, London



THE
INDUSTRIAL PRESS
PUBLISHERS

ALEXANDER LUCHARS
PRESIDENT

MATTHEW J. O'NEILL
GENERAL MANAGER

ROBERT B. LUCHARS
SECRETARY

FRED E. ROGERS
EDITOR

ASSOCIATE EDITORS
ERIK OBERG
FRANKLIN D. JONES
CHESTER L. LUCAS
EDWARD K. HAMMOND
VICTOR BROOK

JUNE, 1917

NET CIRCULATION FOR MAY, 1917, 22,964 COPIES

HIGH-WATER MARK FOR MACHINE TOOLS[1]

The war period has witnessed an unprecedented increase in the number of American machine tool builders, but this increase has been in proportion to normal requirements except in the manufacture of engine lathes. Figures recently compiled by MACHINERY show that 110 manufacturers had in the last three years taken up the production of engine lathes, in addition to about 40 such manufacturers previous to the war. Of the 110 new manufacturers, 29 have discontinued the production of lathes, 24 expect to discontinue, and 57 expect to continue, more than doubling the number in business before the war. Of the 110 concerns, 67 were building standard lathes, and 43 single-purpose or shell lathes; 48 of the 110 were building on contract for established lathe manufacturers, or for dealers, and 62 for the general market.

It is not easy to shift from one product to a radically different one and back again; but some manufacturers have made money by doing this, and have now abandoned the lathe business for their original product, or for some other. Few of these have been so fortunate as a New England concern identified for more than a generation with a well-known product in no way related to machine tools. This concern is said to have received orders for about $250,000 worth of lathes from one dealer and for another $25,000 worth on their own account. On all this business they realized a handsome profit, and when they decided to give up the manufacture of lathes they made an additional profit on the sale of planers, milling machines and other tools which were bought to handle the lathe work, and which had advanced in price so that they could be sold second-hand for more than they cost new at the time they were bought.

Although the sales of lathes far outnumber those of any other machine tool, there is no line in which there is such strenuous competition, and as we return to normal conditions it will be increasingly difficult for new and unknown concerns to turn over their product at a profit in competition with old and well established firms who have up-to-date manufacturing and selling organizations, and whose product is well known throughout the industry. Lathes sold themselves during the height of the war demand for machine tools, and this has caused some inexperienced manufacturers to feel that the selling end of the lathe business will continue to take care of itself. Most of them have produced only one size; but to meet competition and secure satisfactory agents they must design and build several sizes so as to have a fairly complete line, and each size must be built in sufficiently large quantities to keep down production costs. The whole proposition will then assume a different aspect, because they will require added equipment which was not considered necessary before, and a total investment far greater than they now have.

Newcomers in the machine tool field will find it more profitable to use their capital and efforts in lines that offer a better future and less competition. There are still abundant rewards for ingenuity and enterprise in the machine tool industry. Its development will keep right on.

[1] By Alexander Luchars, publisher of MACHINERY.

* * *

SPECIALIZING IN MECHANICAL WORK

Successful specialists in mechanical work not only know their own work, but have a general knowledge of other branches bordering on or closely allied thereto. In fact, specialization usually increases the ability to focus on one line of work a general fund of knowledge. For instance, a man who is an expert in originating mechanical devices has, as a rule, developed his inventive faculties by studying the details of a great variety of machines and mechanical movements. This is also true of the expert tool designer, who is an expert because he possesses a broad knowledge of general manufacturing requirements. A competent machine designer not only knows how to build a machine on paper, but possesses a general knowledge of manufacturing methods. The experienced designer must understand the work which is to be done in the pattern-shop, foundry, machine shop and tool-room in producing the machine or mechanism that is drawn on paper. Machine design involves not merely the designing of a machine that will perform the necessary work, but also the arrangement and shaping of the different parts so that the work of manufacture is not only practicable, but capable of being done on an efficient basis. Hence the most successful specialist is the man that has the broadest general knowledge combined with an extensive specific knowledge of the work with which he is occupied. The machinist, toolmaker, foreman or designer who appreciates the present-day requirements in the shop and drafting-room is not content with a one-sided experience and a mechanical education which is bounded by his own limited observations. He recognizes the value of a broad general knowledge obtained by reading, in addition to the knowledge obtained by practical experience.

* * *

MANUFACTURING PRINCIPLES

It is not an uncommon impression that the shop which is manufacturing an ingenious machine or device employs numerous interesting tools and methods of construction. This is not necessarily true. The rule is that any manufactured device is generally made by simple standard methods unless it is produced in large quantities. Then there is afforded the opportunity for the development of special machines and methods, jigs, fixtures, etc.

Some of the simplest products made in large quantities are produced by the most ingenious methods and machines. When a product is turned out in hundreds of thousands or millions annually, the manufacturer is warranted in spending large sums in the development of special machines or processes for reducing costs. A machine that reduces the cost of a product one per cent may pay for itself several times over in the course of a year's use.

In the manufacture of motor cars, the same rule holds. High-priced motor cars made by concerns that turn out only a few hundred yearly are made with the aid of ordinary machine tools, and very few special machines are employed. Much of the work is done by hand, and the so-called refinements, especially, are generally produced by skilled hand work. On the other hand, the manufacture of low-priced cars made in large quantities affords opportunity for the development of highly specialized plants, using special tools and machinery and having the work routed in such a manner as to produce the largest possible amount with the least waste of time.

STOPPING A SHOP LOSS

BY CHARLES C. LYNDE[1]

In one of the larger factories in an Eastern town, high-priced tool steel had been disappearing for some time and all efforts to trace the theft to some of the employes in the department where the shortage was reported were unsuccessful. When detectives were employed in the place of regular workmen and under the guise of "efficiency experts," nothing vanished. One man was kept on for over a month in the hope that he might catch someone in a renewal of the thefts, and after he had worked for about three weeks, the steel again began to disappear nearly every night, but he had to give up without producing any tangible evidence. The management did not want to stop and search all the men as they left the plant, fearing that this would humiliate those who were not guilty and possibly warn the culprits if they were unable to search all the men from the "tainted" department the first evening, or if the men happened to be leaving without any of the steel at the time of the search. Finally, when the daily loss was beginning to affect the nerves of the superintendent and the tool-room foreman, a plan was devised for detecting the fraud.

The men working in the suspected department entered the plant through a narrow aisle, along one side of the clock house, and stopped midway of the passage to time-stamp their cards. A small paymaster's window was opposite the time stamp, so that the timekeeper could watch the men as they registered in and out. One Saturday night, when the plant was deserted save for the watchman, the superintendent, foreman and timekeeper took to the factory, in the superintendent's automobile, the component parts of a platform scale of the recording type. A section of the clock-house floor was taken up and the scale mounted across the passageway, with its platform level with and replacing the section of floor removed; the dial was placed inside the timekeeper's office. A trip lever attached to the platform was also placed in the office. Unless this lever was released, the platform was rigid, and so the swaying of that section of the floor, which might have aroused suspicion as the men walked over it, was prevented. The matting that had been in the aisle was placed over the platform, completely hiding from casual inspection all traces of the work. The timekeeper then practised, with the superintendent, the releasing of the trip so gently that it could not be noticed by a man standing on the platform directly in front of the window.

The next Monday morning, instead of having the time cards in the usual rack by the clock, a notice was posted there that temporarily each man would get his card at the window in the morning and would turn it in there at night—the cards to be used meanwhile in figuring a cost-cutting scheme. As each man went to the window to get his card, the timekeeper gently released the latch on the scale and the man's weight was registered on the dial within the office. The timekeeper then called out the man's check number, and as he stamped and handed out the card, the check number and scale reading were entered in a double record by a man seated out of the sight of the entering workmen. That evening, the tool-room force was instructed to turn in its cards at the time office instead of merely ringing out on the clock. As this was done, the men's weights were recorded with their check numbers, as in the morning. A comparison of the records showed that most of the men checked out from one to three pounds lighter than they had checked in—but that three men had gained in weight, during their day's work, from nine to fourteen pounds. This record was taken daily for a week. On some days none of the men gained in weight, while on others the scales showed that some of the men were carrying away more than they had brought in.

At the end of the week the men were asked to work overtime—to get the plant's other employes out of the way—and the foreman planned the work so that all of the men could not leave at once. As the jobs were finished, the men were told that they would collect their wages for the week at the pay window in the time office as they turned in their cards. The first of the three men found over-weight when leaving was told at the window that there seemed to be some discrepancy in his account and was asked to step into the superintendent's office to help check up the week's work. The same excuse was made to the two other men under suspicion, save that each was assigned a different office to which he should report.

The superintendent, having been 'phoned that his suspect was coming, took out his copy of the week's scale record and got ready for his caller. On entering, the man was at once accused of taking the tool steel, the superintendent saying bluntly: "Mike, we want you to return to the company, to-night, the forty-two pounds of tool steel you have carried away from here this week." And in refutation of the man's indignant denial of the theft, the superintendent merely read off a detailed account of the number of pounds taken each day, with the dates of theft, winding up with an offer to reinstate the man to his old position if he would confess his part in the theft, make full restitution, and tell who else was implicated. The first two conditions the man gladly accepted, but would not admit that he knew of any others involved in the disappearance of the steel.

The second suspect, sent to the factory manager's office, on being asked to return at once some fifty-odd pounds of tool steel, blurted out: "So ye caught Mike and Joe, and they peached on me!" And then raved on, telling what he would do to them when the opportunity offered. But while he was in the midst of his denunciation two officers, stationed in an inner office, were called in and given charge of the man.

The third man, sent to the head time office, was the only one who happened to be trying to get away with any of the tool steel that night. On his way to the office he became suspicious and hid the dinner pail, in which he had secreted the steel. Then, a little farther along, his fears overcame his desire for the week's pay and he sneaked out of the plant without calling for the money, or even returning for the dinner pail.

The first man was put on probation after he had pointed out the shop in a nearby town to which the stolen steel had been sold and had paid the market price for the steel he was checked up with having carried away, as well as one-third of all previous losses. The second man was brought to trial for larceny and sentenced. While the only trace ever found of the third was his dinner pail, filled with tool steel, which was discovered in the yard a few days later. As no material disappeared after this, the recording scale was taken out as secretly as it was installed and the former time system restored, without the other employes even suspecting that a check had been kept on them.

[1]Address: P.O. Box 468, Pittsburg, Pa.

* * *

THE STUMPF UNIFLOW ENGINE PATENT LITIGATION

The decision of the U. S. District Court for the Western District of New York, which has just upheld the Stumpf uniflow engine patents, in a suit brought against a Buffalo concern for infringement, illustrates some interesting points regarding patentable inventions. It was claimed by the defendants that engines with admission valves at the end of the cylinder and engines with central exhaust ports controlled by the piston have been known for many years, and that some patents already expired have, in fact, been issued covering engines of this kind. The plaintiff, however, claimed that the combined use of an inlet port at the cylinder end, an exhaust port at a distance from the inlet port, means for heating the steam within the cylinder near the inlet port on account of the admission end of the cylinder being hot and dry, a relatively cold chamber into which the exhaust port leads, and a piston adapted to uncover the exhaust port when near the end of its working stroke and cover the exhaust port during the remainder of the stroke, constituted the invention involved in the uniflow engine, and his view was upheld by the court. The fact that other engines had elongated pistons, others central ports, and still others steam jackets, was not held to invalidate the Stumpf invention, inasmuch as in this invention these various elements had been combined in such a way as to reduce the internal loss of the steam engine materially and make a high ratio of expansion in a single cylinder possible.

REORGANIZATION OF A RUN-DOWN PLANT

INCREASED PRODUCTION SECURED THROUGH REARRANGEMENT OF DEPARTMENTS AND EQUIPMENT

BY EDWARD K. HAMMOND[1]

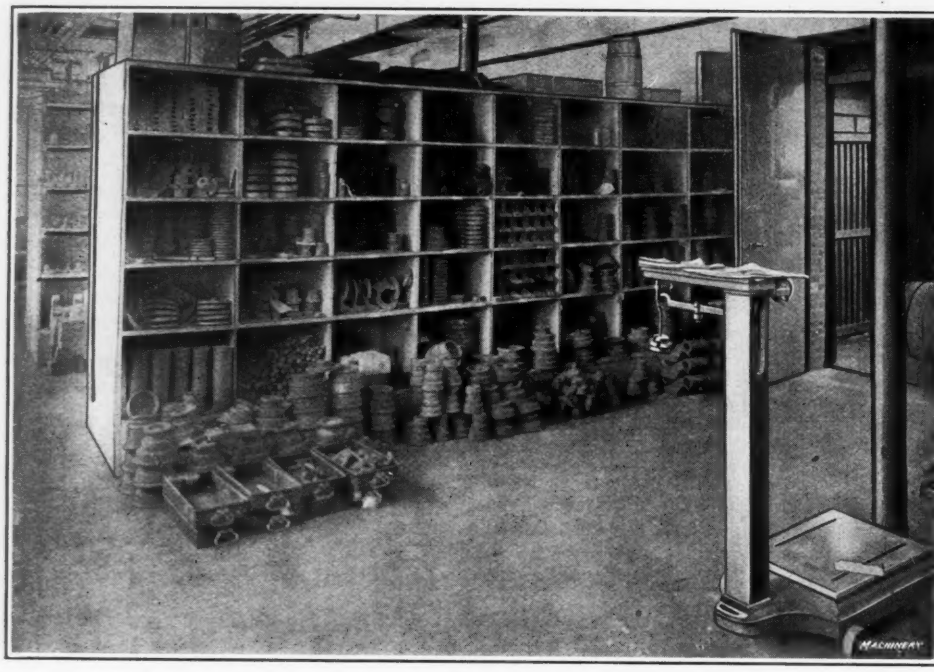


Fig. 1. General View of Receiving Room. Attention is called to New Freight Elevator seen at Extreme Right, and also to Bins for Storage of Small Castings, Machine Parts, etc.

IF any man with a broad knowledge of the conditions existing in our manufacturing plants were asked whether he thought that the average shop is getting the greatest possible return in product and profit, his answer would undoubtedly be that it is not. So far there would be uniformity of opinion, but if the questioner went a step farther and inquired as to the reason why the average shop is failing to take the maximum advantage of its opportunities, there would probably be diversity of opinion. This diversity can be explained by the different ways in which men view the same problem, and also by the fact that people have formed their opinions by a study of different shops in which conditions vary.

Viewing the subject broadly, it is possible that there is no one cause of impaired efficiency that has a greater effect than poor arrangement of equipment in different departments of a factory and lack of system in laying out these departments in relation to each other. In most instances, this condition is simply due to a lack of foresight in laying out the shop and in providing for expansion. As the demand for the company's product increases, additional manufacturing facilities are provided, space being made and machines set up without giving the proper attention to the relation of these new departments to those previously organized, and to the work involved in transferring material and product from one department of the factory to another. Where such a condition exists much time is lost in transferring work through the shop, and it is impossible to secure the maximum production.

Experience of Rivett Lathe & Grinder Co.

The bench lathes and precision grinding machines made by the Rivett Lathe & Grinder Co., Brighton District, Boston, Mass., have won for themselves a favorable reputation in the mechanical world. It goes without saying that this reputation is based upon sound principles of design, the use of materials well suited for the different purposes to which they are applied, and the employment of highly skilled workmen, which is especially important in building precision machines of this kind. Such a reputation should be of great value to the sales department of any factory, but, despite this advantage, the Rivett Lathe & Grinder Co. had not been making money for several years. For this reason it was decided to make a radical change in the management of the factory. A. F. Orcutt was appointed general manager, with authority to take any steps that his judgment led him to believe would ultimately be the means of increasing the earning capacity of the plant.

A brief consideration of existing conditions made it apparent that no great improvement in manufacturing efficiency could be effected until there had been a rearrangement of equipment in the factory. It was the old story of a plant that had added to its equipment as the business grew, but beyond grouping the different kinds of machines in departments, there had been little effort at systematic arrangement. In several rooms the machines were distributed in such a way that it was exceedingly difficult to find passage for the trucks that carried the raw material to the machines and removed the finished product. Also, the arrangement of lineshafts, countershafts, etc., was such that the power transmission efficiency was low and it was difficult to drive the machines to their full capacity. Another source of loss arose from making a practice of building machines in very small numbers—say ten in a lot—instead of in sufficiently

Fig. 2. View in Lathe Department. Note Systematic Arrangement of Machines and Countershafts, also Open Aisle Space to facilitate Trucking

[1]Associate Editor of MACHINERY.

high numbers so that advantage could be taken of every possible saving in the process of manufacture.

After reaching the conclusion that these were two of the greatest sources of loss, it was decided to make them the starting point in carrying out the scheme of rearrangement. In all work of reorganization, it is probable that opposition will be encountered—or, at best, lack of hearty cooperation—from the old employes. After having time to become familiar with conditions in the factory, it became apparent that there were a number of unusually efficient employes in the plant who had been failing to produce results simply because the methods of manufacture under which they were working made the attainment of such results practically impossible. This was one of the most encouraging features, because with such men it was merely necessary to point out the way and they would have the ability to produce results. A careful study was made of the rank and file of employes in the shop, and as a result, some men were let go who showed themselves to be possible trouble makers. Then a campaign for greater efficiency was started among the remaining employes by getting them together, explaining just what steps were to be taken to improve conditions in the factory, and laying particular stress on the fact that this program not only included the provision of means for obtaining greater manufacturing profits, but also the bettering of conditions under which the work was done. This bid for the cooperation of the men proved the means of gaining their support, and enabled the work of reorganization to be carried on with far greater dispatch than would otherwise have been the case.

Rearrangement of Mechanical Equipment

Before starting to change the arrangement of machinery in the shop, floor plans were laid out to scale, and paper dummies representing each machine were then cut out to the same scale. These dummies were arranged in the different departments, and conferences were held with the respective department heads concerning the best way of laying out the equipment. After a tentative arrangement of the machinery had been made for each individual department, a general conference was held at which all department heads were present, and at this time there was a further discussion of all the conditions that might effect efficient transportation of work from department to department. Not until after the conclusion of this general conference was a single dummy pasted down on the floor plans. Then working from these plans, the drafting-room laid out complete floor plans showing the arrangement of all the equipment; and corresponding plans were drawn to show the arrangement of all the shafting on the ceiling of each shop. These shafting lay-outs were made on tracing cloth and their accuracy in relation to the different machines was checked by laying the tracings over the floor plans. In this connection it is of interest to note that the millwrights worked from these lay-outs in setting up the equipment and everything lined up without the least trouble.

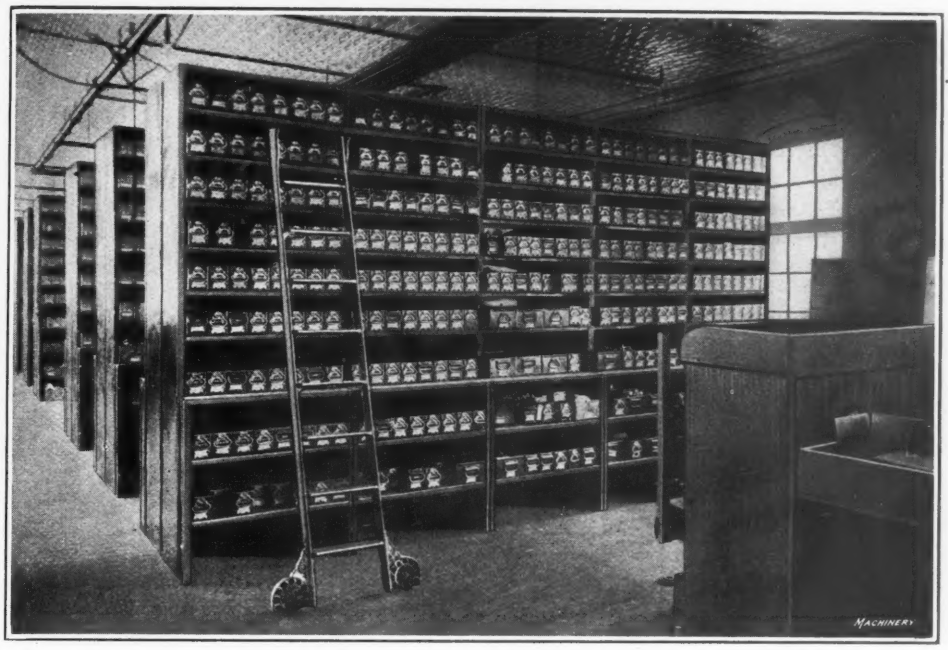


Fig. 4. View in Finished Stores Department to which are sent All Finished Parts required in assembling Complete Machines. All Furniture is made of Metal, and is Fireproof and Practically Indestructible

General Summary of Departmental Lay-out

The plans made for rearranging the equipment were based on three general principles: First, to provide convenient and efficient means of receiving raw materials and transferring such materials from the receiving room to the finished stores department or to the shops; second, to provide for systematic routing of work from department to department and for the maintenance of open aisles in all shops, so that the work of transportation could be done as rapidly as possible; third, to furnish transmission equipment that would enable the machines to be driven to their full capacity without unnecessary consumption of power.

Outside the wing of the factory that adjoins the railroad, there is a receiving platform on which are discharged raw materials and supplies, and from which machines are loaded for shipment. In this connection it was found possible to make a material saving. Under the old management a firm of contractors in Boston had handled trucking on a basis that involved an average expenditure of $300 a month. So a decision was reached to purchase a

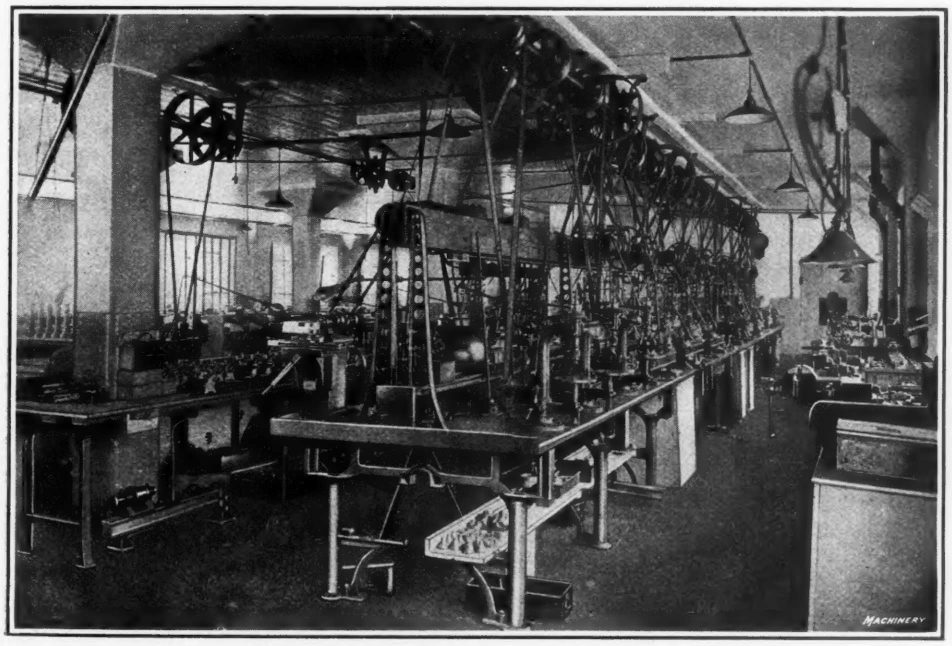


Fig. 3. View of Department equipped with Work Benches and Bench Machines for handling Small Work. Everything is systematically arranged, making Confusion Practically Impossible

motor truck in order that the company could itself transfer shipments between the plant and docks, and make local deliveries. Eventually a Pierce-Arrow truck was bought for this purpose, and it is earning at present a handsome return upon the expenditure involved in its purchase.

Fig. 5. General View in Assembling Department. Attention is called to the Large Number of Machines of One Type that are in Process of Manufacture

To facilitate the transfer of materials and product from floor to floor of the factory, a freight elevator was provided at the shipping room, space for this elevator being made by building a brick extension on the outside of the building. The shop is three stories high and arranged somewhat in the form of the letter T. The departments are arranged as follows: Running along the top of the cross-bar of the letter T is the shipping platform, and on the main floor in this section of the building there is storage space for castings, bar stock, etc.; also, there is a sawing department for cutting up bar stock into workable lengths. On the second floor is located the automatic screw machine department and the shipping room, while the third floor is given over to the grinder room and to the inspection and finished stores departments. In the section of the building corresponding to the upright of the letter T, the ground floor is given over to a department in which planers and boring mills are located, the second floor is devoted to lathes and milling machines, while on the third floor there is a bench machine department for handling small work, and the remaining space is occupied by the assembling department.

Having made this brief statement as to the lay-out of the shops, we are in a position to discuss the manner in which work is routed through the factory. It has already been mentioned that castings and bar stock come to the receiving room, where they are entered on books maintained by this department. Heavy castings are placed directly on elevating trucks and sent through to the planer department to be machined, while small castings, which come to the shops in larger quantities, are sent through into the stock-room, from which they are drawn out on requisition. Instructions were given the foundry, from which castings are bought on contract, as to the exact metal mixture that ought to give a grade of iron suitable for parts of the Rivett machines, and this has been the means of greatly increasing the quality of castings received.

The bar stock taken into the factory at the receiving room goes to the sawing department, where it is cut up into the desired lengths for working, and these short bars are then sent up to the automatic screw machine department located on the second floor. The product of this department is then sent through the inspection room to the finished stores department on the third floor, from which parts may be drawn out on requisition by the assembling department. Bed castings and other castings machined in the planer department on the ground floor go up to the inspection department on the top floor of the building, and the same is true of parts machined in the lathe and milling machine departments located on the second floor. But there is this point of difference; heavy castings go through the inspection department and are sent straight out to the assembling floor, while smaller parts, after being inspected, are sent to the finished stores department, from which they are drawn on requisition by the foreman of the assembling room.

After being assembled, the finished machines are sent to the inspection room, and after being passed by the inspectors, they go down in the elevator to the shipping room located on the second floor. Having the shipping room on the second floor and finished stores on the third floor may seem somewhat illogical, as the natural arrangement would be the reverse. But it was found impracticable to have the third floor of the building support the weight created by an accumulation of finished machines. This arrangement is not inconvenient, however, because the elevator facilities make handling of both the finished machines and the product a simple matter.

Fig. 6. General View in Factory under Old Management, which shows Considerable Evidence of Lack of Systematic Arrangement of Equipment

Maintenance of Open Aisles through Shops

There are few steps that can effect greater savings in han-

dling material than the maintenance of open aisles through which loaded trucks may be pushed without interruption. In working out the arrangement of equipment in the different shops, it was decided to leave space for aisles of ample width, and the aisles are indicated by white lines three inches in width, which are painted at each side of the aisle space. It is a rule of every department that no work or material shall be allowed to extend over these lines, and once every two weeks the shop painter goes over the lines so that they are plainly visible.

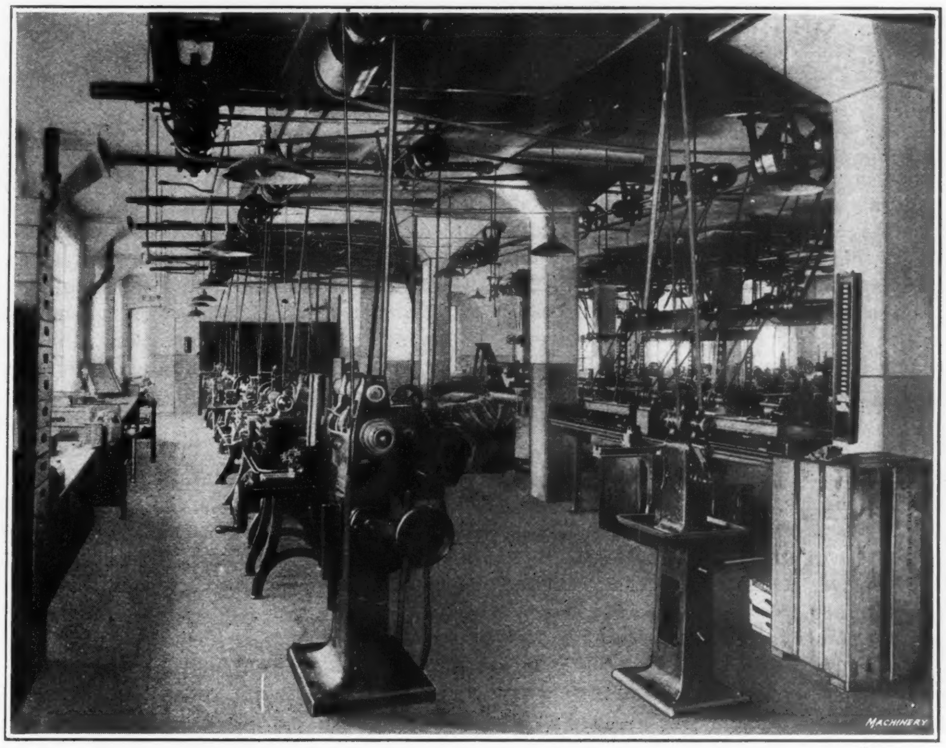


Fig. 7. Illustration showing Conditions that existed under Old Regime. Particular Attention is called to Lack of System in arranging Lay-out of Machines, Tangle of Belts and Dirty Ceiling, which greatly impair Chance of obtaining Sufficient Illumination

Arrangement of Lineshafts and Countershafts

All lineshafts in the factory are carried by hangers mounted on three- by six-inch timbers of the best quality available in the market. These timbers are bolted to the ceiling and provide a foundation for accurate shaft alignment. There is no noticeable vibration, and the proper driving conditions may be obtained for every machine, so that it may be driven to the limit of its productive capacity. This stands out in marked contrast to the cases that are too often seen where shafting vibrates considerably and where it is only too apparent that conditions of the driving equipment make it impossible to secure anything like the normal capacity from the majority of the machines.

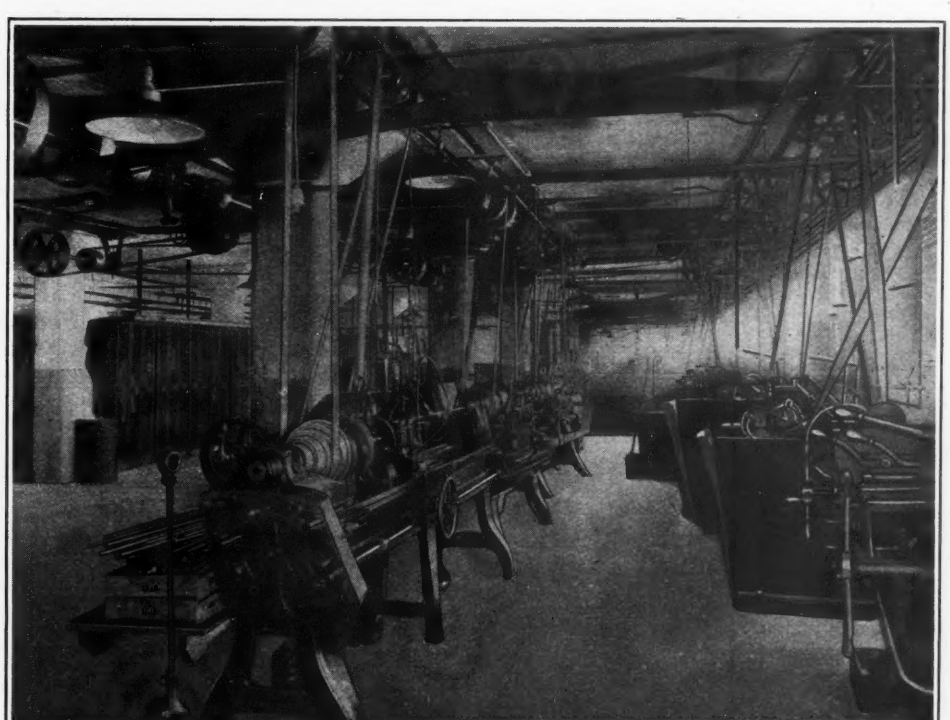


Fig. 8. View in Automatic Screw Machine Department as conducted under Old Management. Here also there is Apparent Lack of System, and General Conditions are Such that Effective Illumination and Rapid Handling of Work are greatly impaired

Painting

All progressive manufacturers agree that good light is an essential of efficient shop work, and in order to secure good light it is necessary not only to have means for taking advantage of daylight and for producing artificial illumination, but the walls and ceilings of each room in the factory should be painted a light color so that distribution of the light may be as effective and as uniform as possible. Realizing the importance of this condition, it was decided to spend plenty of money on paint, as it was felt that an expenditure in this direction was far more desirable than loss of money through spoiled work and failure to obtain the maximum amount of work from each machine. As a result, a painter is employed who continually goes over the shop. He paints the walls and ceilings—and renews the aisle lines when necessary—and this man is never afraid of "working himself out of the job," because his orders are to start over at the beginning as soon as he has completed one round. This may look like an unnecessary expense, but many manufacturers who have tried the scheme out find that expenditure on light colored paint applied to the shop walls is usually a paying proposition.

Manufacturing in Large Units

Possibly one of the greatest losses of possible profits that was suffered by the Rivett Lathe & Grinder Co. under the old management was due to manufacturing machines in too small numbers. Practice varied with different machines, but the number made in one lot ranged from ten to fifty and was usually nearer the lower figure. Now the minimum number of machines carried through the shop is fifty and the number in a lot runs from fifty to two hundred, according to the machine and the nature of the work involved in the manufacture of its parts. Operating in this way, it is possible to take advantage of many savings which are impossible in cases where only a small number of machines are manufactured at a time.

WORKMEN'S COMPENSATION ACTS

LAWS COVERING INDUSTRIAL CONDITIONS

BY CHESLA C. SHERLOCK [1]

THE workmen's compensation acts necessarily cover a large field, so that an attempt to discuss them even briefly would require considerable space. This discussion, therefore, will be confined to a consideration of the compensation acts as they apply to industrial conditions. The ideal way of treating this subject would be to print the various statutes and then give the courts' views of their several differences. But inasmuch as this is impossible, the English workmen's compensation act is taken as a model upon which the illustrations of the law are based. Practically all American compensation acts, except for a few minor technicalities, are identical with the English law.

Prior to the enactment of the workmen's compensation law in England, an injured employe had only the common law on which to rely. It was ordinarily necessary for him to bring suit against his employer and run his chances of a recovery. The common law had allowed employers to raise up defenses that very often cut off the employe's chance of a recovery. Then, again, a recovery that is based upon litigation is bound to be slow and expensive. Oftentimes, the litigants died before their respective rights were settled by the courts. Toward the end of the nineteenth century, the fact was quite generally accepted that the cost of injuries received in the production of wealth was a part of the cost of production and should be borne by the consumer along with other similar costs, instead by being borne by the injured employe.

The result was the English workmen's compensation act, which was passed in 1897. This law has been modeled by practically every country in the civilized world; it is in force in some twenty-five or thirty different jurisdictions. Article I, Section 1, of the act provides:

> If in any employment (where act applies) personal injury by accident arising out of and in the course of the employment is caused to a workman, his employer shall, subject as hereinafter mentioned, be liable to pay compensation.

Section 2 provides that:

> (*a*) The employer shall not be liable under this act in respect of any injury which does not disable the workman for a period of at least one week from earning full wages at the work at which he was employed.
>
> (*b*) When the injury was caused by the personal negligence or willful act of the employer or of some person for whose act or default the employer is responsible, nothing in this act shall affect any civil liability of the employer, but in that case the workman may, at his option, either claim compensation under this act or take proceedings independently of this act; but the employer shall not be liable to pay compensation for injury to a workman by accident arising out of and in the course of the employment, both independently of and also under this act, and shall not be liable to any proceedings independently of this act, except in case of such personal negligence or willful act as aforesaid.
>
> (*c*) If it is proved that the injury to a workman is attributable to a serious and willful misconduct of that workman, any compensation claimed in respect of that injury shall, unless the injury results in death or serious and permanent disablement, be disallowed.

Section 3 of Article I provides that any question as to the amount of compensation, as to whether the injured person is a workman or not, or anything else affecting the parties under the act that cannot be settled by agreement, shall be settled by arbitration. As Sections 4 and 5 do not have any bearing upon industrial questions, they have been omitted.

What Constitutes an Accident

Under Section 1 recovery is based upon injury by accident. Probably 90 per cent of the first cases brought under the act were to determine the meaning of the phrase "injury by accident." Lord Halsbury has held that it is interpreted according to its ordinary and popular meaning; Lord Macnaghten has followed the same reasoning in another case. Another court held that the word implied something "fortuitous and unexpected." The House of Lords defined an accident as "an unlooked-for and untoward event which was not expected or designed." Elsewhere they defined it as "any unexpected personal injury resulting to the workman, in the course of his employment, from any unlooked-for mishap or occurrence."

In interpreting these definitions, the courts have held a nervous shock caused by a fatal injury to a fellow workman to be an accident. So a strain produced by over-exertion in attempting heavy work is now considered to be an accident. In the case of internal injuries caused by strain or over-exertion, however, such injury is not considered to be an accident. Disease is not regarded as an accident, and where the real incapacity is the result of disease instead of the injury, there will be no recovery. It should be remembered in this connection, however, that compensation is not based upon the extent of the injury, but upon the extent of the incapacity resulting from such accidental injury. Hernia, or rupture, is held to be an accident within the meaning of the act. Said Lord Macnaghten: "If a man, in lifting a weight or trying to move something not easily moved, were to strain a muscle, or rick his back, or rupture himself, the mishap, in ordinary parlance, would be described as an accident. Anybody would say that the man had met with an accident in lifting a weight or trying to move something too heavy for him." A stroke of apoplexy said to have been brought on by a strain is not an accident. Death from erysipelas of the face, three months after an injury to a hand, is not an accident. Death from heart disease is ordinarily not an accident. Typhoid fever, enteritis, colic, eczematous sores, dermatitis, abscesses, paralysis, and cardiac breakdowns are not accidents. But where a disease is a consequence of an accident, although not the natural result or even the probable result of such accident, it is deemed an accidental injury within the meaning of the act. However, there is ordinarily no recovery for a purely occupational or industrial disease or disease arising independently.

Injuries Arising in Course of Employment

The injury must arise out of and in the course of the employment in order for a recovery to lie. It is not sufficient for a workman, according to the English decisions, to show that his injury arose out of his employment. He must also show that it arose in the course of the employment. These two requisites must be strictly followed. Because of the difficulty in determining just what this phrase means, the courts have said that each case must, in a measure, depend on its own circumstances. The American courts, as in the interpretation of the words "accidental injury," have quite uniformly followed the English rule in this particular. In fact, all through the law of compensation, the courts of the two countries stand shoulder to shoulder, so that it would be hard to distinguish between their decisions.

Said one court: "The words 'out of' point, I think, to the origin or cause of the accident; the words 'in the course of' to the time, place, and circumstances under which the accident takes place. The former words are descriptive of the character or quality of the accident. The latter words relate to the circumstances under which an accident of that character or quality takes place. The character or quality of the accident as conveyed by the words 'out of' involves, I think, the idea that the accident is in some sense due to the employment. It must be an accident resulting from a risk reasonably incident to the employment." As one authority puts it: "The risk must be one peculiarly incident to the employment, and not one incurred by everyone, whether in the employment or not." For instance, where a workman, while driving an engine on his employer's farm, was stung by a wasp and died from blood poisoning, the risk is not one peculiarly incident to the employment. Where a workman in a mill was injured while removing his socks in order to do his work better, such

[1]Address: 707 Youngerman Bldg., Des Moines, Iowa.

injury is not one arising out of and in the course of the employment. "If there be any risk in a man's taking off his own socks, it is a risk common to all who wear them. It is no greater to a man who works in a spinning mill than to one who does not work in a spinning mill." Where one is injured by lightning, it was held to arise out of the employment, in a case in which the workman, because of the character of his place of work, was peculiarly liable to be struck. But an employe working in a street is no more liable to be struck by lightning than any other person, and no compensation can be recovered therefor.

In order that the injury may be one arising out of the employment, the workman must be acting within the scope of his employment at the time of his injury; compensation is not recoverable where the danger is voluntarily incurred in doing acts wholly outside the scope of employment. "Compensation will not be allowed where a workman goes to satisfy the requirements of nature into a dangerous and unauthorized place, or on premises not under the control of the employer."

The fact that the workman does the act causing the injury in a wrong or dangerous manner will not, of itself, defeat compensation; or where the act was within the scope of employment, but the workman had been expressly forbidden to do that act, recovery will not necessarily be defeated. The real distinction here is drawn as to whether or not the servant was actually doing the work he was employed to do or something substantially different. It has been held that mere disobedience of orders will not defeat the employe's right of recovery. In one case, the workman was forbidden to oil the machinery when it was in motion. In doing this he was injured and was allowed to recover. In another case, a workman was forbidden to sit down when at work, but was allowed to recover. It is obvious, however, that if the disobedience amount to a serious and willful misconduct on the part of the workman, there can be no recovery.

Extent of Injury

Section 2 (*a*) provides that there can be no recovery for an injury unless such injury shall be sufficient to incapacitate a workman from receiving wages for at least one week. As the act was originally passed it provided two weeks as the minimum time, but it was amended in 1906 to read as it does now. This section is self-evident to all, and the courts have quite generally held that the interpretation which would be placed upon this section by an ordinary person after reading it is the one that will be followed by the courts.

Choice of Remedies

According to Section 2 (*b*), an employe has the right to proceed under one of two courses. He may either recover under the act or bring suit under the common law. It will be observed that the option rests upon the employe in this respect. In many of the states the law is made mandatory on the employer and optional as to the employe; in others, it is optional as to the employer up to a certain time designated in the statute and fixed as to the employe. In these latter jurisdictions, it has been held that the employe's only right rests entirely upon the compensation act. This is a detail, however, that is covered by the respective statutes in each state operating under the compensation law. Some question has arisen as to the effect of the word "workman" as used in this section of the act. Suppose the workman dies of his injuries. Does his cause of action or right of election die with him? The courts have been of the opinion, and justly, that the rights of the workman pass to his dependents or legal representatives. However, if the workman has made an election or taken affirmative steps toward an election, such decision will, ordinarily, be binding on his dependents or representatives.

A workman receiving compensation for injuries is not entitled to wages also; neither is a workman entitled to part compensation and part damages. He must take one or the other. As to what amounts to an election, the courts have been of the opinion that each case must be a law unto itself. The real criterion is the actual intention of the workman or his representatives. Oftentimes, this intention is inferred from the overt acts.

Misconduct of Workman

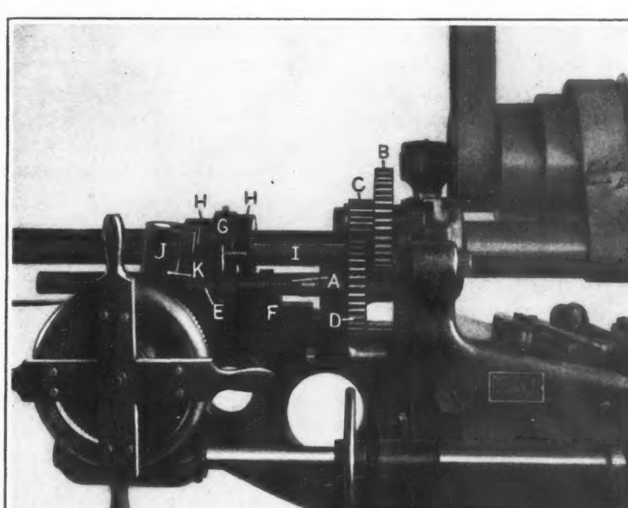
Recovery of compensation is denied if there is a "serious and willful misconduct" on the part of the workman. According to the English interpretation of this phrase, the act itself must be serious and not merely the consequences thereof. Intoxication has been held to be serious and willful misconduct. In their decisions, American courts have said that the phrase means something more than mere negligence or even gross negligence. They seem to adopt the view that "serious and willful misconduct" involves conduct of a quasi criminal nature, or doing the act with a wanton and reckless disregard of its probable consequences to others. A Massachusetts decision said that it closely resembled the wanton or reckless misconduct which will render one liable to a trespasser or mere licensee. A California case said: "It cannot be doubted that a workman who violates a reasonable rule made for his own protection from serious bodily injury or death is guilty of misconduct, and that where the workman deliberately violates the rule with knowledge of its existence, and of the dangers accompanying its violation, he is guilty of willful misconduct."

* * *

THREAD CUTTING ON OLD HORIZONTAL BORING MACHINE

BY ROBERT MORRIS

The illustration shows an old Binsse horizontal boring machine which was used for boring transmission cases in a shop in northern New York. Some of the holes in the transmission cases had to be threaded, so after boring they were tapped. As this method of doing the work proved inaccurate, it was decided to bore and thread the holes at one setting. The threads to be cut were not more than one inch in length and of only one pitch, 16 per inch. The lead-screw *A* was U. S. standard, with about eight threads per inch. A gear was mounted on the spindle of the machine to mesh with a gear *B* of the same size. On the same spindle with *B* and keyed to it was a pinion *C*, one-half the size of gear *D*, secured to the lead-screw; this gave the proper reduction to obtain the correct feed of the bar for threading. The lead-screw rotated all



Horizontal Boring Machine arranged for Thread Cutting

the time, but the nut *E* was split and was held open by a spring. The nut was secured to a slide *F* with an arm *G* reaching up and embracing the boring-bar *I*. On each side of the arm were collars *H* fastened to bar *I* with set-screws. These allowed the bar to rotate but prevented end play. The holes were first bored with the boring-bar, in the usual manner; as the half-nuts were held open by the spring, the bar was free to feed endwise either by hand or by the power feed. When the hole was bored to the correct size for threading, the horseshoe-shaped piece *J* was swung down on the half-nuts and closed them on the lead-screw. The piece *J* was pivoted on pin *K*. With a tool like a chaser, having several teeth, the holes could be threaded at a single pass. The metal was an aluminum alloy.

ZINC PLATING AS A PROTECTION AGAINST CORROSION

BY J. W. WUNSCH[1]

The corrosion of iron and steel, its inhibition and prevention, are questions of extreme importance that today are confronting engineers and manufacturers of machinery. The causes, effects, and substance of corrosion have been live topics of discussion among metallurgists and founders, but the problem of protection against corrosion, which concerns machine builders more directly, has not received the attention its importance would justify. We are all informed, in a general way, that oils, paints and the plating of non-ferrous metals prevent the rusting of iron and steel, while "they are on," but few persons know the comparative efficiency and actual worth of the various preventives. This article is not a treatise on corrosion, but a statement of the general principles, processes of application, and comparative efficiency of zinc plating, or galvanizing.

It is a well-known fact that zinc forms a cheap and excellent coating for the protection of iron and steel against corrosion. It has the inherent advantage over tin and lead of being electro-positive to iron, and is attacked in preference to iron when the two metals, in contact with each other, are exposed to the corrosive elements. Tin and lead form an efficient preventive of corrosion only when they completely envelop the article; that is, when no part of the iron or steel is exposed to corrosion. Any exposed part will quickly corrode and the rust will readily work under the plated part, causing the entire article to become corroded in a short time. With zinc plating, however, even when the coating is imperfect and a part of the metal is exposed, the iron will be protected from corrosion, to a great extent, so long as the zinc remains in sufficient quantity to make an effective couple. The earliest recorded application of the zinc-plating principle is that employed by Sir Humphrey Davy in 1824, who attempted to protect the copper sheathings of ships by means of zinc bars attached to them.

There are three general processes for the deposition of zinc on iron and steel, namely, hot-dip zincing, or hot galvanizing; sherardizing; and cold-zincing or electro-galvanizing. In spite of its name, galvanic action has no part in the first process. Until quite recently, this method of zinc deposition was used almost exclusively for large and medium size work, and is still employed mainly in the galvanizing of sheets, wire netting and bulky articles. The process is carried out as follows: The articles are first thoroughly cleaned, usually by pickling them in sulphuric acid and then scrubbing, washing and rinsing in clean water. They are then dipped in a bath of molten zinc, which must be kept at a temperature somewhat above the melting point of zinc, 774 degrees F. The hotter the zinc the thinner is the coating, but excessive as well as low temperatures are attended with many serious disadvantages and should be avoided. In the plating of sheets and other thin flat articles, it is common practice to use moderate temperatures, and the excess zinc is cleared off by passing the articles between rollers.

The sherardizing process of zinc deposition was invented by Sherard Cowper-Coles, who found that metals embedded in zinc dust and heated to a moderately high temperature, although considerably below the melting point of the zinc, become coated with a layer of the metal. The zinc dust commonly employed is a by-product obtained in zinc manufacture, and consists of pure zinc mixed with the zinc oxide. In carrying out the process, the articles are placed in an air-tight vessel, with the zinc dust, which has previously been thoroughly dried, and subjected to a heat varying from 250 to 330 degrees C. The longer the articles are treated, the heavier will be the zinc deposit; the duration of the process ranges from one-half hour to three or four hours. If an air-tight receptacle is not available, a small percentage of powdered carbon is added to the zinc dust, to prevent an increase in the amount of zinc oxide, which, if present in excess, tends to make the deposit dull.

[1]Address: 1581 Lincoln Place, Brooklyn, N. Y.

Electro-galvanizing Method

In the electro-galvanizing process, which is of comparatively modern development, the zinc is deposited electrolytically from a bath containing approximately a 10 per cent solution of crystallized zinc-sulphate. The essential elements of an electroplating plant are: the plating solution, or electrolyte; the receptacle for holding the latter and fittings; the anodes, which are zinc bars suspended in the electrolyte in proximity to the article to be plated and connected to the positive pole of a dynamo; and the cathode, which is in contact with the article and is connected to the negative pole of the dynamo. The electro-zincing of sheets, large iron receptacles, etc., is mainly done in still plants, which are essentially like the elementary apparatus just described. Work that is plated in still-solution tanks has a white frosty appearance, but can be easily brightened by giving it a scratch brushing. A good deposit should be obtained in a still-solution apparatus in from one-half hour to an hour.

Mechanical plating plants may be divided into two types, the plating barrel, for plating small work in bulk, and the conveyor type plants, or "moving" tanks, for large work. Material that is plated in a rotating barrel will not have the frosty appearance of work plated in the still tank, for the reason that the tumbling motion imparted to it causes a burnishing effect while the deposit is going on, which results in the work coming from the barrel in a bright condition.

In its elementary features, the plating barrel may be described as a drum made of a non-conducting material, perforated, supported in bearings, and rotated in a tank containing the electrolyte. The positive pole of the dynamo is connected to the zinc anodes, which are hung around the barrel. The negative pole is connected to the cathode conductor within the barrel, which is in intimate contact with the material. The plating barrel may be filled with work to a depth of three-quarters of the diameter, if it is of the totally submerged type, and about two-fifths the depth, if it is of the partly submerged type. These machines are rotated at from four to twelve revolutions per minute, depending on the grade of work. Plating barrels are made in various sizes up to a capacity of about 200 pounds of small work, such as nails, conduit boxes, etc.

The mechanical conveyor-type of plant, in its essentials, consists of a tank fitted like the still tank, and which, in addition, is equipped with a continuously moving conveyor mechanism of an endless chain or feed-screw type. The articles are hung on racks, which are fastened to the conveyor chain or screw, carried through the solution, and returned to the starting point. The time of travel is adjusted to suit conditions and requirements; in average practice, the rate of travel through the solution is about one foot a minute. The constant movement of the work through the solution permits a higher voltage to be used than in the still tank, thus employing a greater ampere current with the consequent acceleration of the plating. Outputs ranging to 115,000 valves plated in a day of nine hours have been obtained from a single installation. Recent mechanical developments of this type are special equipments for galvanizing pipe, bar iron, angles, and other structural shapes. They are automatically carried through the tank, being turned as they advance, so that an even coating is procured. The pipes are then washed, drained, and delivered automatically. Flat and round wire and wire cloth are galvanized in continuous lengths, washed, dried, and reeled up automatically.

The voltage employed in electro-galvanizing ranges from five to fifteen volts, depending on the class of work, the quality of the solution, and the speed of operation. Higher voltages will cause the work to "burn" and must be avoided. The amperage necessary is directly proportional to the surface to be plated; 1000 ampere-hours will deposit 42.8 ounces of zinc. It is common practice to allow 10 amperes for every square foot to be plated. A good deposit, in a mechanical plating apparatus, requires from one-half hour to two hours. The actual length of time of deposit depends on the class of work, current density, and the thickness of the deposit required.

The electro-galvanizing process is without question the most efficient and desirable from every consideration. Although the

hot-dip process is still used extensively for certain kinds of work, and will doubtless be used for some time in the future, the writer is convinced of the eventual supersedure of the other processes by the electrolytic process. Some inherent advantages of the latter over hot galvanizing and sherardizing are as follows:

It deposits a uniform coating of chemically pure zinc; hence much less zinc is required.

The adhesion of the deposited metal is better (482 pounds per square inch, against 280 pounds per square inch) and more flexible, so that plated sheet metals can be spun and plated wire bent without cracking the coating.

The temper and tensile strength of the material are not affected. Tempered articles, such as automobile hardware, frequently lose in tensile strength and temper when subjected to the heat of the molten bath (774 degrees F.) of the hot-dip process.

Bolts, nuts, and similar articles with small recesses are coated so smoothly that they require no recutting.

These advantages are confined to the efficacy of the electroplated deposit in comparison with the product of the other processes of zinc deposition, and they, alone, are of interest to the engineer or manufacturer. There are, however, many other advantages of extreme importance in the operation of a plating shop. Among these are: economy of metal and time, decrease of upkeep expense, perfect control of process, and the elimination of the necessity of expert and high priced operators.

Decisive Test for Determining Zinc Deposit on Plated Article

A simple decisive test for the comparison of galvanized products and the quali-quantitative determination of the zinc deposited on a plated article is the copper-sulphate dip test. This determination may be readily made by anyone, as it does not require any special skill. The article to be tested is thoroughly cleaned in water and immersed for one minute in a saturated solution of copper sulphate (bluestone). It is then withdrawn, quickly washed in water, and briskly rubbed dry with a towel. The chemical action is very simple, the sulphate tending to dissolve the zinc and plate the copper on the exposed iron ($CuSO_4 + Zn = ZnSO_4 + Cu$). If the article shows no copper plating that cannot be effaced with the cloth, it is said to have withstood a one-minute test. These one-minute dips are continued until a distinct copper plate appears on the iron or steel. An article that is plated for other than esthetic reasons should stand at least two one-minute tests, as described.

* * *

ENGINEERS AS EXECUTIVES

Both the Pennsylvania R. R. and the Baltimore & Ohio R. R. recently appointed as general managers of their respective systems men who are engineers by training and experience. The selection of engineers for executive positions is becoming more and more recognized as a valuable aid in obtaining efficiency and high standards in management. Unfortunately, in many industrial undertakings in the past the leading executive positions have appeared to be closed to engineers, the assumption being that the engineer is not fitted to handle executive and financial problems as well as engineering problems. It is obvious, however, that training along engineering lines promotes clear thinking and requires decisions in which mistakes are not permissible, so that an engineer of good judgment can be trusted to arrive at proper decisions in any executive position if he is otherwise qualified to handle the work.

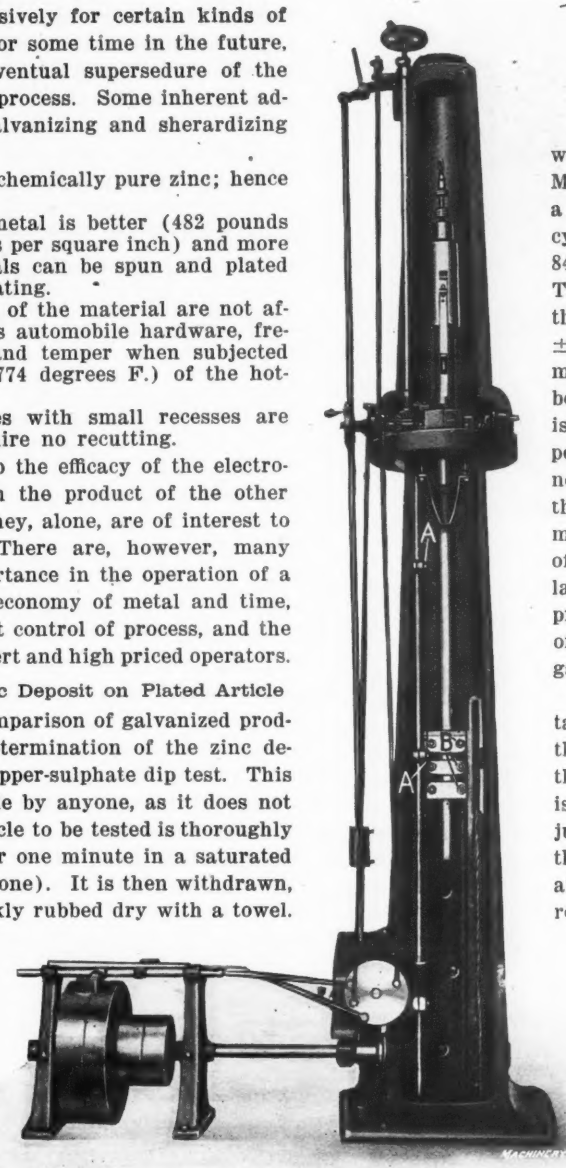


Fig. 1. Keyseater designed for slotting Recoil Cylinders

SLOTTING RECOIL CYLINDERS

BY W. J. LARSON [1]

The Catlin keyseater shown in Fig. 1 was built especially by the Chattanooga Machinery Co., Chattanooga, Tenn., for a Western factory manufacturing recoil cylinders. It has a maximum stroke of 84 inches and cuts a length of 54 inches. The gage must fit the entire length of the cylinder, though a tolerance of ± 0.001 inch is allowed, and all surfaces must be smooth. The cylinder to be bored is shown at *E*, Fig. 2, and a finished cylinder at *F*. The bore must be perfectly straight and its diameter must not vary more than 0.001 inch. After the bore is brought to the right size by means of a wood back reamer, the ends of the cylinder are turned to fit the collars on the keyseating machine and the profile of the finished cylinder is marked off on the upper end by means of the gage shown at *D*, Fig. 2.

The proper length of stroke is obtained by setting the dogs *A*, Fig. 1; then the cutting head is assembled to the bar. The proper height of the bar is obtained by loosening nuts *B* and adjusting the bar by means of the eyebolt that is screwed into the cutter-head after removing the adjusting screw. The roughing cutter is then assembled in the cutting-tool holder, which, in turn, is assembled to the slotting bar. The indexing mechanism is shown in Fig. 3 and the cutter-bar in Fig. 4.

The cylinder to be slotted is passed over the end of the cutter-bar and fastened in the clamping collar *A*, Fig. 3. As the head, Fig. 4, is forced downward, the spring *A*, acting through the tool-holder plunger *B*, and the resistance of the metal force the cutting-tool holder *C* up the wedge *D*, pushing the tool outward, and causing it to cut a slot of uniform depth. On the return stroke the tool-holder is forced down from the wedge and back into the bar away from the work. The depth of the cut depends on the position of the wedge, which is easily adjusted by the screw *E*. Spring *A* and plunger *B* keep the cutting tool *F* in its proper place and prevent it from boring into the work. Three tool-holders are used. One has, in the center of its upper end, a slot that is parallel to the side; one has a slot forming an angle of 3 degrees to the right hand; and one has a slot forming the same angle to the left hand. All the cutting tools are made of high-speed steel and are hardened and ground. The wedge *D* is a casehardened steel forging.

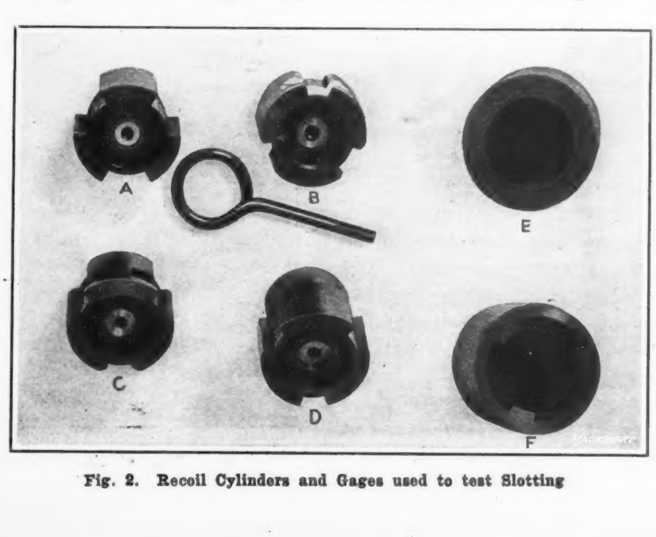


Fig. 2. Recoil Cylinders and Gages used to test Slotting

After the tool is fed to its proper depth, circular feed is engaged to cut from the side of one rib to the next rib, leaving 0.01 inch for the finish cut. The same operation is repeated between the other two ribs. The roughing tool is then removed, by simply removing the pin that holds the cutter in position, and the

[1]Address: 2212 Scott St., Davenport, Iowa.

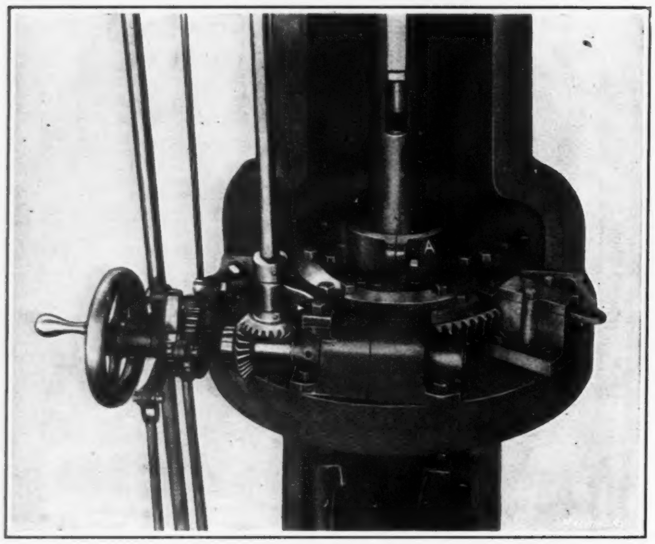


Fig. 3. Indexing Mechanism of Catlin Keyseater

left-hand side tool is assembled in its place; when the three left-hand sides are machined, this tool is replaced by the right-hand side tool and the right-hand sides are machined. The cylinder is now roughed out, and the next operation is to finish the diameter between the ribs. In the roughing operation it is necessary to have the bushing of the cutting tool 0.004 inch smaller than the bore of the cylinder; in the finishing operation, the bushing should not be more than 0.0005 inch smaller than the bore in order to make a perfect job.

To change the cutter-head so as to put in the finishing tool is a simple operation; by turning, the draw-in rod is tightened or loosened, which is a handy arrangement. After the roughing head is removed and the finishing head is assembled, the radius cutter is placed in the cutting-tool holder and the sharp corners removed so that they will not cut the bushing. The finishing tool is then put in place and fed to its proper depth, measuring from the center of the opposite rib, or what is left of the bore. After the diameter is finished between the ribs, the side tools are used and the three sides are machined until they are equally spaced; when tested with gage *A*, Fig. 2, all three sides must bear against the gage. The opposite side tool is now used and one rib is finished, using gage *B*, which fits one rib only. Gage *C* fits the arc between the ribs; and after that has been in all three arcs, the master gage *D* should go in, which fits all the slotted surfaces.

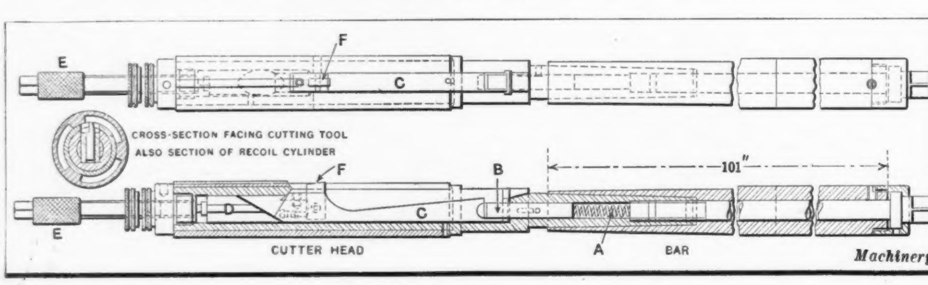


Fig. 4. Cutter-bar of Keyseater

* * *

The shipbuilding industries will, of course, remain exceedingly busy for many years after the war is over. The extent to which orders have already been placed, however, will be surprising to many. The Danish shipbuilders, Burmeister & Wain, have their entire capacity, amounting to about one 10,000-ton ship a month, definitely ordered up to 1922. It is interesting to note that not a single steamer is included in these orders, all of these vessels being Diesel-driven motor ships. According to *Marine Engineering*, inquiries are being made at the present time with the view of building in America two hundred wooden motor ships, each of 2000 tons' dead-weight capacity, and nearly as many vessels of about 4000 tons' dead-weight capacity. J. A. Cole, chief engineer of the *Abelia*, says in *Motorship:* "Modern marine Diesel engines have reached such a stage of reliability that there is not the slightest doubt that in a few years' time they will be in advance of the steam engine. At present there are motor ships crossing the Atlantic, keeping as good time as steamers, and coming through heavy weather without hitch to the motors."

LATHE ACCESSORIES IN A SMALL SHOP

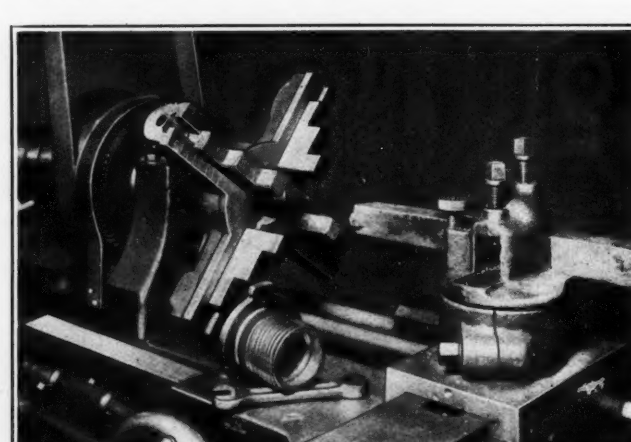
A small shop owner in Syracuse has certain ideas in regard to the construction of lathe chucks, toolposts and chuck adapters. For this reason he makes his own chucks and orders his lathes without toolposts. The chuck is much the same as any other independent chuck except that the body, instead of being made round, is cast with four arms which are provided with jaw slots and screws for operating the jaws as usual. This construction provides ample strength and reduces the weight. The shape of the chuck and light weight make it convenient to put on the spindle. It can also be conveniently loosened by placing a block in the path of one of the arms and turning the spindle backward, pulling the belt by hand.

The upper part of the toolpost is cast with a slot sufficiently large to accommodate the largest turning tool used in the lathe. Two large binding screws hold the tool rigidly in place. The toolpost is also cut away in front to accommodate a boring tool or boring-bar, which can be put in place quickly. The boring tools are held rigidly by the forward screw. The lower part of the toolpost is machined to a circular shape about three or four inches in diameter. This end of the toolpost fits snugly in a bored hole in the cross-slide casting which is split and furnished with a binding screw for tightening it. For minute adjustment of the cutting edge up or down, the tension on the lower split portion is released and the thumb-screw in the upper portion is turned forward or backward, raising or lowering the tool to suit the requirements.

The adapter bushing shown is useful in a shop where there are lathes of different makes and a variety of spindle noses. These adapter bushings make it possible to use a chuck made for one lathe spindle on another lathe with a different size spindle. The lug provides a convenient means for removing the adapter from the spindle or the chuck as the conditions may require.

V. B.

The cross form of chuck reduces the cast iron required for the chuck body somewhat, but the design is one that a "safety man" would not favor because of the obvious danger of the projecting arms. Chucks, in general, should be made with a smooth periphery, and projecting screws or lugs should always be avoided. As a matter of fact, the saving of metal in the form of chuck shown is more apparent than real; a well designed chuck of the conventional form is made with a comparatively thin wall of metal between the jaws, and the rim is also made thin and light. The bulk of the metal is immediately around the jaw slots, and the thin wall of metal between the jaws and in the rim adds but a few per cent to the total weight. The extra weight of the common chuck body is well worth the cost because there is less likelihood of injuring the user, which is a consideration of prime importance in design.—EDITOR.



Cross Form of Chuck, Adapter Bushing and Special Toolpost

FAILURE OF THE CARBURIZING PROCESS[1]

The carburizing or cementation process of adding carbon to iron or ferrous alloys is so ancient that its origin cannot be traced. Metal workers for many centuries made good steel by selecting the materials and process; but they did not know that it was the carbon they added to the metal that gave the desired results. In fact, it was only in the last decade that this fact became known. But the cementation or carburizing process used by the ancient steel makers is still used for many purposes, especially for making the blister bars used in crucible-steel manufacture. The modern electric melting furnace, however, is rapidly displacing the crucible process and has revolutionized the making of the higher grades of steel. With it, the impurities can be reduced to lower percentages and a more homogeneous steel can be made. More important still, the cost of making these high grades of steel is less than with the crucible process.

The carburizing process is also used in the manufacture of some important machine parts. Probably the automobile industry uses more carburized parts than all others put together, although this industry is credited with being the originator of many new processes and methods for manufacturing steels of greatly improved quality, as well as having brought into practical use many alloys that have doubled and trebled the power of the steel to resist alternating and rotary vibrational and torsional strains, as well as the wearing properties, elastic limit, etc. Any of these alloys, when properly worked and heat-treated, will give better results than carburized steel. Many of the better grades of carbon steel can also be made to develop better wearing surfaces and greater resistance to strains. For instance, in the transmission of a car made in 1907 two of the gears were of air-hardened steel and the other of carburized steel. To withstand the strains to which these gears were subjected, the latter was made 7/8 inch wide, while the others were only 9/32 inch wide. Not only did the use of the air-hardened gears reduce the cost, for only one-third the weight of steel was required, but it was also possible to reduce the weight of the frame, axles, wheels, tires, and all parts that had to carry these parts. In addition, it would be possible to reduce the horsepower of the engine, and thus lessen its weight, as well as the weight of the driving shaft, driving gears, and other moving parts.

Of course, a low-carbon steel can be machined more rapidly than one that is high in carbon, which is one of the reasons why the carburizing process has remained. Stellite and the improved high-speed steels, however, have reduced the difference in machining time to a small percentage, so that this argument is rapidly losing its force. Besides, against the argument of the saving of time in the machine shop must be figured the cost of the carburizing material and furnaces, fuels for the operation of the furnaces, the time required for packing the steel parts, charging the furnaces, and removing the work from the furnace, and for quenching and reheating the parts for the second hardening. When that is done, it will be found that the carburizing process is rather expensive.

Wearing Qualities of Carburized and High-carbon Steels

The principal argument advanced in favor of carburized parts is that they have a hard outer surface that will resist wear to the greatest degree and a tough center that will prevent breakage. However, these are not found to be the facts. Hardness alone is not the property that will give the greatest wear to two surfaces rubbing against each other. Bronze gears running in mesh with carburized steel gears outwear the steel gears, yet the carburized steel gear teeth are much harder than the bronze gears. Also, gears made of Hadfield's manganese steel will wear longer than four or five carburized steel gears, yet it does not show nearly the degree of hardness of a high-carbon steel. Extreme hardness in the steel carries with it a brittleness that causes the steel to wear away more quickly than when it is drawn back enough to show the troositic structure, and this reduces the brittleness to a certain degree of toughness. Glass is considerably harder than a steel file, but the former is so brittle that the file breaks away particles of it until it is cut to the desired size or shape. The same thing occurs when a hard steel gear or other part is worn away by a softer but tougher metal, so that toughness is more important than hardness. It is possible to select steels that will give the correct degree of hardness and toughness when they are merely hardened and tempered, and thus do away with the expensive and crude carburizing process. We will then have machine parts that are as strong at the center as on the outside and can reduce the sectional area or the weight of steel used for a given performance.

Straight carbon steel will resist twice as much load as the core of the carburized steel before it will stretch enough to take a permanent set, but the elongation and reduction of area of the soft steel will be double that of the harder steel. This might indicate that the softer steel will withstand the greatest transversely applied or torsional load, but this torsion is as bad a feature as breakage in a piece that must fit others to work in unison with them. As distortion will either cause the piece to break or will break the pieces with which the distorted piece comes in contact, nothing is gained by having a soft ductile center and a hard outer shell. It is folly to claim "a tough center that will prevent breakage." The steels containing from 0.12 to 0.18 per cent carbon, which are generally used for carburized parts that contain approximately 1 per cent carbon in the outer shell, seldom have an elastic limit of more than 40,000 pounds per square inch, and this cannot be increased much more than 5000 pounds by any heat-treatment. If a steel with a high enough carbon content to give the best shearing surface is used, the elastic limit can be raised to more than 100,000 pounds per square inch.

One series of transverse tests was conducted with pieces ½ inch round and 12 inches long, loaded at the center between 10-inch supports. The best results obtained with carburized 0.20 per cent carbon steel was a load of 1760 pounds, with a deflection of 0.5 inch, while a straight oil-hardened 0.50 per cent carbon steel withstood a load of 3025 pounds with a deflection of 1.55 inch. Both were practically the same steel except for the carbon content. The carbon content of the outer shell of the carburized steel was raised to 1.22 per cent, while at a depth of 0.2 inch it decreased to 0.30 per cent.

Failure of Carburized Ball and Roller Bearings

In the early days of the bicycle, ball and roller bearings first came into general use. Then the cups, cones, races, and even the balls and rollers were carburized. Manufacturers soon learned, however, that the hard outer shells of the balls would compress against the soft centers and cause them to deform; then the bearings soon failed. Many of the balls would also break and crack between the hard outer shell and the soft core, causing the shell to peel off. When the manufacturers resorted to a straight carbon steel and gave the balls a uniform hardness clear to the center, they found that a given size of ball would carry a much larger load. Later they found that chromium steel was best for this purpose.

In the carburized cups and cones, a groove formed where the balls applied their greatest loads. This was caused by the metal in the soft core flowing away from the compressive force applied by the load carried by the balls as they rolled around the cup and cone. This groove was equalized until the hard carburized shells on both sides of the cups were pressed together; but after a time the carburized shells peeled off and destroyed the bearings. These troubles were overcome when the manufacturers abandoned the carburized process and made all their ball-bearing parts from steel that had the correct chemical composition to start with. They would then heat-treat the parts correctly and have a uniform hardness and chemical composition clear through the steel. Attachments for taking up wear were abolished and the present high-grade ball bearings outwear automobiles. At that, they carry more than twice the load they did in the bicycle days.

That many parts of roller bearings are still being carburized is due to the fact that a roller has a comparatively larger bearing surface than a ball. As a consequence, the weaknesses of carburized parts have not developed as quickly as with ball

[1]Abstract of a paper by E. F. Lake read before the Steel-treating Research Club of Detroit, April 27, 1917.

bearings. Nevertheless, there is a steady growth in the number of roller-bearing parts that are being given a straight hardening and tempering without carburizing.

Carburizing Difficulties

In carburizing steel, there are many difficulties encountered and it is doubtful if all are overcome in any given batch of metal. Probably the most troublesome is the breaking of the carburized shell away from the core. If a steel is correctly carburized, there is no distinct bark to shell off, as the carbon content will gradually reduce from something like 1.25 per cent on the outer surface to the 0.10 to 0.20 per cent steel in the core. In commercial work, however, there is nearly always a distinct demarkation between the zone of high carbon and the core. When hardened, a high-carbon steel increases in volume much more than a low-carbon steel; therefore, there is considerable stress between the high-carbon and the low-carbon parts of a carburized piece every time it is hardened. This often results in rupture parallel to the outer surfaces, which is seldom seen until the carburized part has failed. One series of tests with nickel steel showed that the specific gravity is greater when the steel is carburized than when it is hardened without carburizing. This is directly the opposite of the effect obtained with carbon steels. Therefore, if the stresses are great enough they will burst the outer shell and develop cracks that can be seen.

Another difficulty is the segregation of carbon, which can easily be caused by raising and lowering the temperature of the furnace during the period of carburization. This nearly always occurs in coal-fired furnaces and often occurs in furnaces that are fired with the best of fuels. It might be caused by a carburizing mixture that was not uniform. Microscopical examinations of one test also showed the segregation of cementite to be most frequent in the pieces that were in the top of the carburizing box. Such segregation often causes thin plates to flake off from the surfaces.

A third and the most serious difficulty is grain-growth. Carburizing steels that contain below 0.18 per cent carbon are very likely to have this fault. The grains begin to increase in size as soon as the transformation point is past, which in this steel is around 1550 degrees F., and continue to grow until the highest temperature is reached during the carburizing process. In commercial work this is often 1750 degrees F. and is seldom below 1700 degrees. This brings us close to the point of crystallization, and when that occurs the steel will retain the coarsened grain structure. If not, and the work is quenched from the carburizing furnace, the coarse grain is likely to remain in the core, even though the work is again heated to a temperature high enough to harden the high-carbon outer shell. Therefore, it is only with the utmost care that the core can be made much better than a filler for the shell.

A steel that is high enough in carbon to begin with and then is simply hardened and tempered correctly, does not present these three difficulties. It is, therefore, much more uniform in strength, toughness and wearing qualities.

* * *

WHY PRESSED STEEL PARTS BREAK DURING MANUFACTURE

BY ERNEST A. WALTERS[1]

Pressing steel is the act of forcing the metal into the desired shapes and forms through one or more operations. The work is done in dies by power presses capable of exerting the necessary pressure to produce the article in serviceable form. In designing the dies and punches, much thought must be given to the steel that is to be drawn. It is always necessary to consider the points from which the steel is flowing and those to which it is to flow, and proper distribution must be made by equally and mechanically balanced dies and punches from the first to the last operation. At all times the fundamental principles governing sheet-steel drawing must be taken into consideration and the aim must be to make an article in the least number of operations.

Many difficulties that require thought and experience for their solution are met in the operation of power presses. It is a good practice to keep a record of these, so that should the same difficulty be met again, the cause will be recognized and its remedy known. The troubles encountered in press work may be divided into three classes: die troubles, steel troubles, and press troubles. Some of the most common of these are given in the following:

Die Troubles

Poor and careless die setting.
Rough radius, causing too much friction.
Dies too tight in one or more points.
One or more radii too sharp.
Drawing on grain of steel, causing it to open.
Lack of air-hole in punch or die or both.
Deep scratches and slug marks caused by previous operation.
Steel strained in one or more points in previous operation.
Hitting bottom of die too hard, causing metal to flatten, harden, and crystallize.
Pressure pad holding too tight at one or more points.
Too great a reduction in one operation.
Protruding screws or dowel-pins.
Use of poor or improper oil.
Defective or poor knock-out construction.
Defective or poor stripper construction.
Use of heavy or wrong thickness of steel.
Burr too large on blank, causing opening in grain.
Edge of blank hardened and crystallized by dull blanking punch.
Punch or die with chip broken off, causing sharp edges to tear.
Screw-holes in upper or lower or both pressure pads.
Die or punch too soft, causing one or more points to upset or enlarge.
Shifting of gages that should be doweled.
Bent or distorted punch.
Drawing from too great an area of stock.
Loose sections in die or punch, causing it to tip when pressure is applied and fracture or cut the steel.
Hole to be drawn out punched out of center in previous operation, causing crack or break.
Punch or die worn out of shape in this or previous operation, causing too great a difference when proper relation must be maintained, thereby producing strains, cracks, and breaks.
Dirt, slugs, or chips accumulating in die or punch.
Too much oil in corners or bottom of stamping.
Steel being drawn between die sections and pressure pad with open screw- or core-holes.
One or more sections too high, causing too much pressure at those points.
Stamping having too many wrinkles from previous operation.
Die slightly shifted out of line with punch.
Die or punch loose, due to vibration.
Die having improper clearance.
Rubber bumper or spring regulating pressure pad improperly adjusted.
Broken springs under pad in die or punch.
Die and punch not parallel, causing unequal drawing and pressure conditions.
Stamping not drawn deep enough on previous operation.

Steel Troubles

Laminated steel.
Badly pitted steel.
Steel too hard.
Steel too soft.
Over-annealed or burnt steel with scale.
Rusty or dirty steel.
Steel not annealed properly, too hard.
Use of dry steel that should be properly oiled.
Steel left in pickling vat too long, causing it to corrode and weaken.
Chilled steel, too cold.
Steel covered by particles of sand and emery dust.

Press Troubles

Press running at too great speed, causing steel to tear by sudden shock.
Gibs on press too loose.
Adjusting ram collar loose, causing lost motion.
Ram not square with bed of press.
Break on drum too loose.
Bolster plate too weak and springy.
Bolster plate improperly bolted, causing it to become loose and shift through pressure and vibration.
Press not having proper foundation, causing blank to shift through vibration.
Cap on pitman at crankshaft loose, causing lost motion.
Poor operator, allowing press to repeat.
Clutch trouble, allowing press to repeat.
Inadequate light, causing poor operating through poor vision of operator.

[1]Address: 219 W. Buena Vista, Highland Park, Mich.

WORK-HOLDING FIXTURES FOR BLANCHARD SURFACE GRINDER[1]

USE OF MAGNETIC CHUCKS AND FIXTURES IN GRINDING

BY DOUGLAS T. HAMILTON[2]

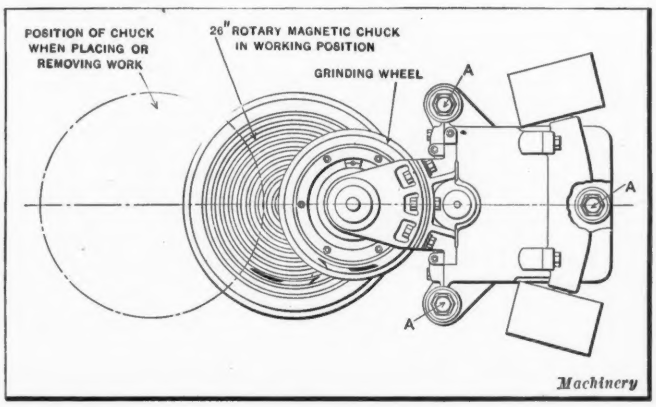


Fig. 1. Diagram showing Loading and Unloading Positions of Chuck on Blanchard Vertical Surface Grinder

THE design of the Blanchard vertical surface grinder adapts it particularly for grinding a large number of small parts. For holding plain parts having flat surfaces, the regular magnetic chuck furnished with the machine is used. When the work is of irregular shape, however, it is necessary to build special fixtures to support the work properly. As far as possible, the pieces are held magnetically, but in some cases this cannot be done. When the part is of such shape that a fixture cannot be designed to hold it magnetically, it is necessary to adopt some means of clamping. It is evident that on this type of machine the part need not be held down as rigidly as on a milling machine, because the wheel tends to hold the work down to a certain extent. The design of fixtures for Blanchard vertical surface grinders should be such that grit or water will not interfere with the operating or

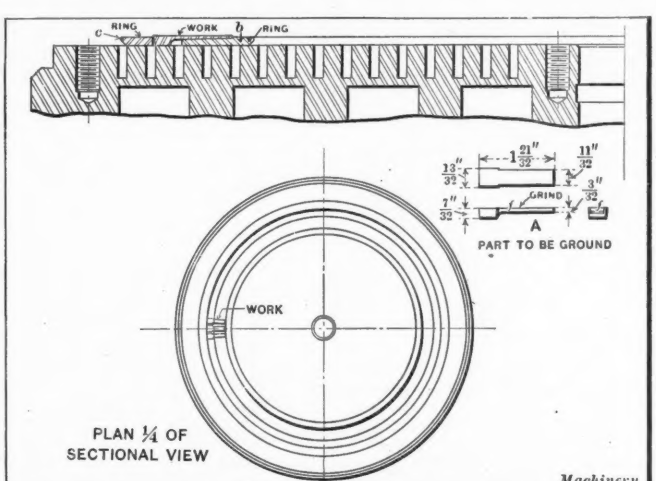


Fig. 2. Fixture used for holding Bolt Stop Springs for Military Rifles

clamping mechanism, and they should also be designed so that they can be removed and placed quickly on the chuck to facilitate cleaning. In the following article attention will be directed chiefly to those types of fixtures in which the magnetism of the chuck proper is used for holding the pieces either directly or through a fixture, the fixtures being designed so that the lines of force are localized at the desired point in order to obtain the greatest possible holding effect.

There is one point about the Blanchard vertical surface grinder that may not be generally recognized, and that is the fact that the work-table can take various positions in relation to the grinding wheel. Normally, as shown in Fig. 1, the wheel reaches slightly past the center of the rotating chuck. The chuck, however, need not be located in this position if the work has projections that prevent the wheel from reaching the center of the chuck. It may occupy a position intermediate between its normal working position and the position that it occupies when the work is being removed or loaded, that is, extending over the outer ring of the chuck surface, leaving the center free so that projections on the work will clear the wheel. In the following description of work-holding devices,

Fig. 3. Method of supporting and holding Cast-iron Guides on Magnetic Chuck made by Blanchard Machine Co., Cambridge, Mass.

it will be noticed that this feature is taken advantage of in several cases.

Magnetic Fixture for Holding Bolt Stop Springs for Rifles

As has been previously mentioned, flat work is held directly by means of the magnetic chuck. When the work has a projection similar to that shown at *A* in Fig. 2, it is necessary to provide some other means of support. This is easily accomplished, as shown, by using cold-rolled steel rings; one of these *b* is located under the tails of the pieces, and the

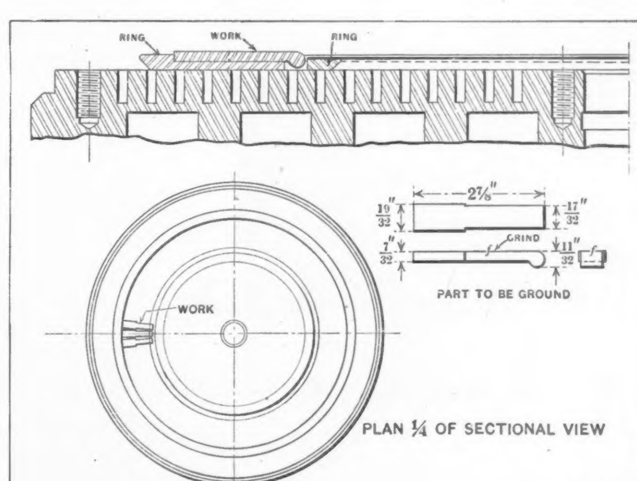


Fig. 4. Arrangement of Steel Rings for holding Parts on Magnetic Chuck

[1] For information previously published in MACHINERY relating to magnetic chucks, see "Holding Work on the Magnetic Chuck for Milling," September, 1915; "Holding Copper on a Magnetic Chuck," August, 1914; and "The Inside of the Magnetic Chuck," April and May, 1914.

[2] Address: Fellows Gear Shaper Co., Springfield, Vt.

other, *c*, surrounds the pieces and thus prevents them from being moved toward the outer edge of the chuck when being ground. It will be seen that the magnetic force passes through the ring *b* and grips the thin part of the work, also holding the work directly at that point where it bears on the chuck. In addition, the outer end is attracted to ring *c*. This fixture is arranged to hold 150 rough forgings, which are ground on one side at the rate of 600 per hour.

Fixture for Holding Cast-iron Guides

Another similar example of a work-holding fixture employing the separate strip principle is shown in Fig. 3. In this case the parts being machined are cast-iron guides, three of which are held on the chuck at one time. The guide, it will be noticed, is of such a shape that its entire bottom surface does not contact with the chuck; consequently, cold-rolled steel strips are placed underneath the part to form additional contact. Other strips placed at the outer edges of the guides prevent the rotating wheel from sweeping them off the chuck. Here it also will be noticed that the chuck holds the parts directly and through the medium of the cold-rolled steel strips.

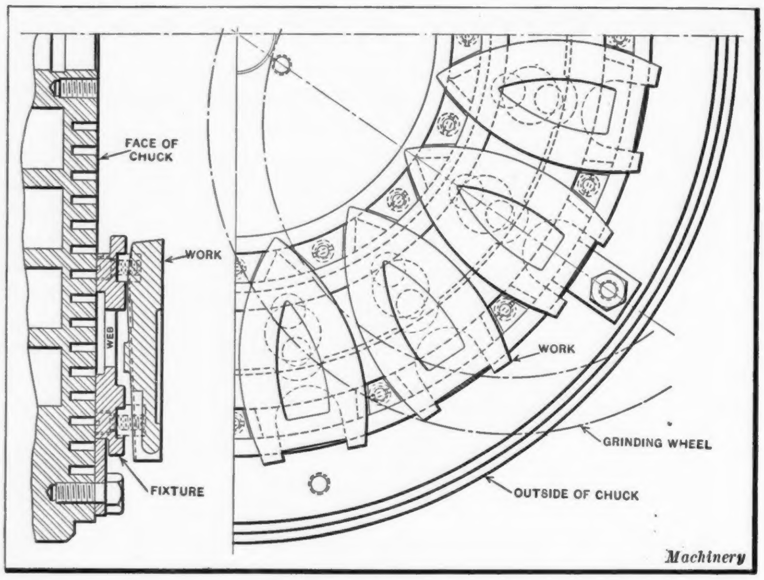


Fig. 7. Special Fixture for holding Electric Flat-iron Clamps on Blanchard Magnetic Chuck

Work-holding Devices for Holding Small Irregular Parts

A fixture somewhat similar to that illustrated in Fig. 2 is shown in Fig. 4. In this case the parts to be operated on are comparatively small and of such shape that they cannot be

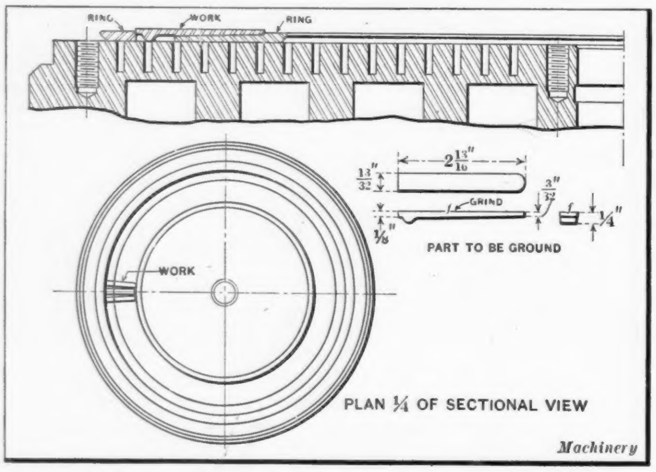


Fig. 5. Method of holding a Magazine Follower on a Blanchard Magnetic Chuck

held directly against the face of the chuck. A ring, therefore, of similar shape to the part being held is located on the chuck and on this the pieces rest. This ring has a projecting boss against which the pieces fit, and another ring located inside the work prevents the parts from being shifted out of line with each other. In the example shown in Fig. 4 the work rests entirely on the plate, the magnetism passing up from the chuck through this thin steel plate, holding the work firmly in place.

Fig. 6. Special Fixture for holding Gibs on Blanchard Magnetic Chuck

Fig. 5 shows a fixture for holding a part similar to that shown in Fig. 4, this being a magazine follower for a military rifle, which is ground on one side only. The fixture provides for holding 120 pieces at one time in the rough-forged condition, and the production is 300 per hour. In this case also two

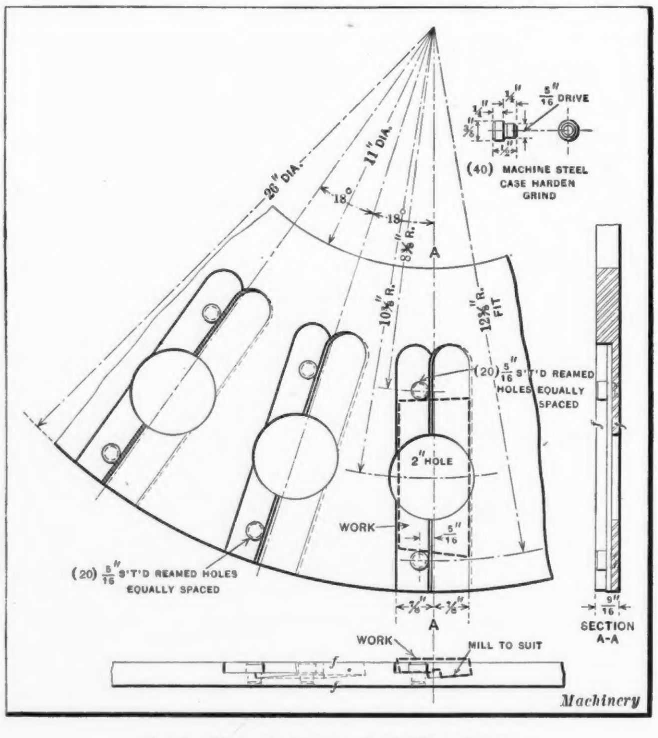


Fig. 8. Magnetic Fixture for holding Cutters

rings are employed, the inner one being formed to suit the work, the circular projection resting on the table; the other ring surrounds the parts on the outer end and prevents them from being swept off the chuck. In the various fixtures shown in Figs. 2, 4 and 5, the retaining rings and blocking plates are made separate to increase the facility with which the rings can be handled while cleaning the chuck. In operating machines with this type of fixture, it is the practice not only to remove the work when it is ground, but also to remove the rings and plates from the chuck each time to facilitate cleaning.

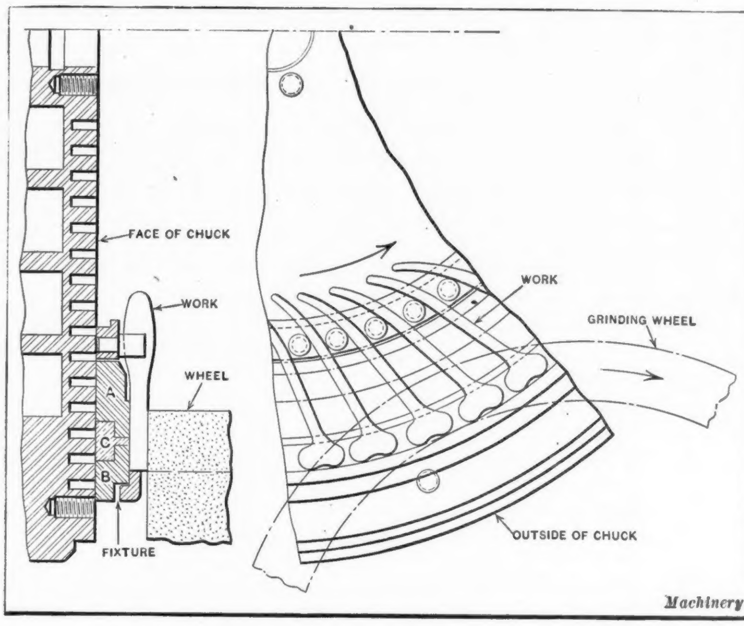


Fig. 9. Magnetic Fixture for holding Handles for Cut Nippers

Fixture for Holding Taper Gibs

An interesting type of magnetic fixture is shown in Fig. 6. The parts being ground are taper gibs for a lathe carriage. These are first ground on two parallel sides to exact thickness; then they are dropped into the milled slots in the cast-iron plate shown, the latter being held on the magnetic chuck of the machine. The bottoms of the slots in this plate have a taper which holds the work at the proper angle to give the taper required on the gib. It is interesting to note that no planing or other machining operations are done on these gibs before they are brought to the grinding machine. The rough castings are put on the grinding machine and approximately ⅛ inch of stock is removed from each side, both at the first and second operations. There is nothing to hold the pieces in the slots except friction and the slight magnetic pull that comes through the plate. This pull, however, is greater than might be expected, owing to the fact that the thickness of the plate at the bottom of the slot is not over ½ inch and the magnetic force is of sufficient strength to prevent the gibs from being moved back and forth in the slot. The gibs are 16 inches long, and the production is from seven to eight per hour, ground on all four surfaces.

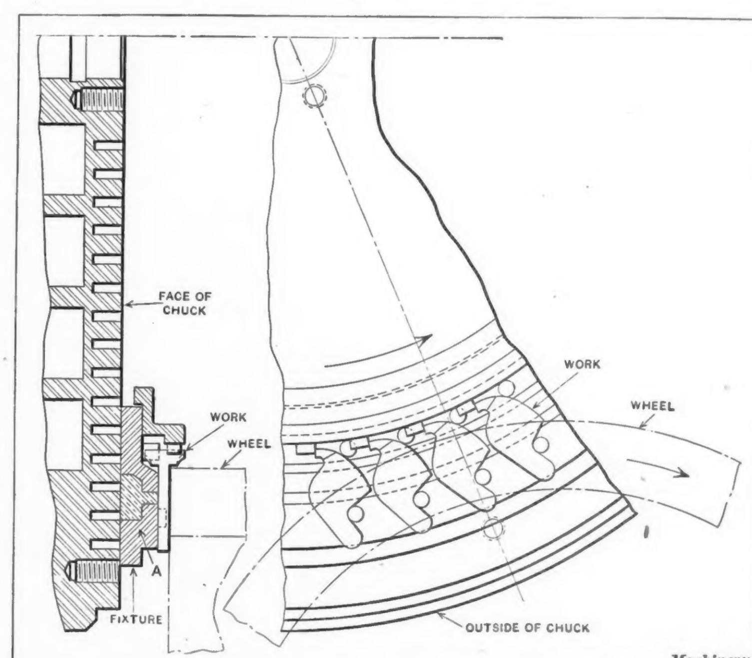


Fig. 10. Similar Fixture to that shown in Fig. 9 for holding Jaws for Cut Nippers

Magnetic Fixture for Holding Electric Flat-iron Clamps

A magnetic fixture for holding electric flat-iron clamps is shown in Fig. 7. As will be seen, this consists essentially of an inner and outer ring of fairly heavy section, which carry hardened steel blocks that locate and support the work. It will also be noticed that the two ring portions of the fixture are connected by a thin web which has further been lightened by drilling a series of holes in it, the idea being to prevent diversion of the magnetism through the entire fixture and confine it to those points where it will most effectively hold the work. This fixture is so designed that it carries sixteen pieces, and the production is 100 electric flat-iron clamps per hour, grinding one side only and removing 1/16 inch of stock.

Magnetic Fixture for Holding Irregular Shaped Steel Cutters

Fig. 8 shows a magnetic fixture for holding steel cutters that have an irregular under surface. Reference to this illustration will show that the plate has holes cut about midway of the length of the piece being held; these are to reduce the plate area and concentrate the magnetism at the points where it will hold the work securely. The fixture is made from boiler plate and is ground on both sides. The work is located by means of stop-pins at both ends.

Magnetic Work-holding Fixture for Cut Nipper Handles

In the type of work-holding fixture shown in Fig. 9 the area of grip on the work is comparatively limited, and hence special means have to be provided to concentrate the magnetism at the points where it will most effectively hold the work. The grinding wheel, of course, sweeps over the flat ends only, and in so doing has a tendency to draw the pieces out of the fixture. In order to overcome this action and also prevent the pieces from shifting sideways, a special fixture is necessary. The fixture body comprises two steel rings *A* and *B*, which are separated by a brass ring *C*. The effect is, therefore, to strongly magnetize these two steel rings, and as they are separated by a non-magnetic substance, the current has to pass through the work from one to the other, thus providing a secure means of holding. The inner ends of the work are separated by studs, as shown, which are held in a third steel ring on the chuck. The capacity of this chuck is 50 nipper handles, and the production is 125 per hour, grinding both sides and removing 1/32 inch of stock from the rough forging on each side.

Fig. 10 shows a somewhat similar fixture for holding the nipper jaws. Here, as before, three rings are provided, the two steel rings being separated by a brass ring; in this way the magnetism is localized in the flat surface of the nipper jaws so as to hold them securely. The inner ends of the jaws are prevented from shifting by means of

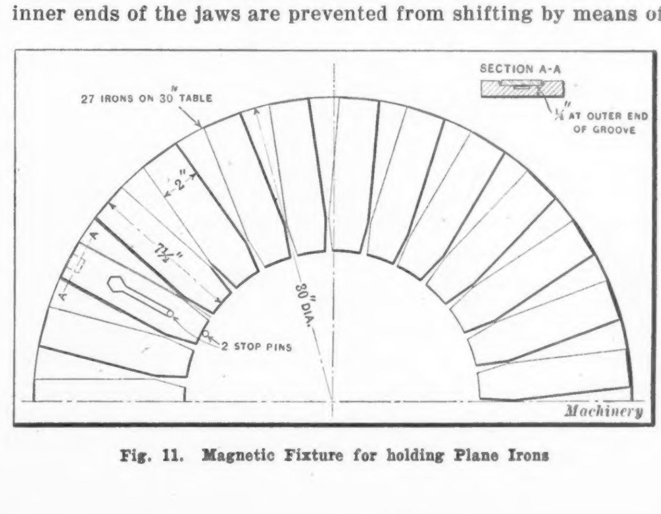


Fig. 11. Magnetic Fixture for holding Plane Irons

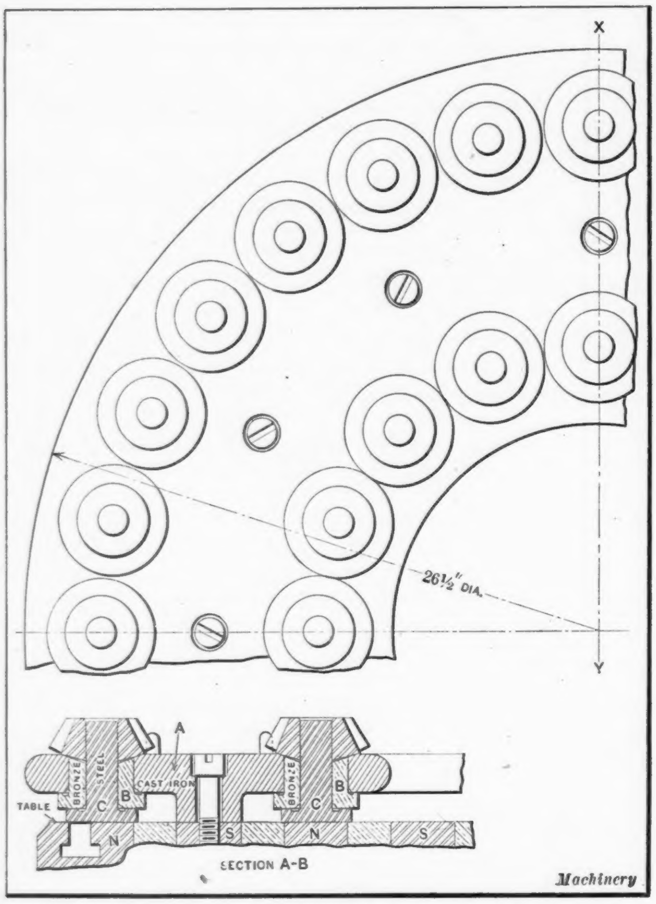


Fig. 12. Magnetic Fixture for holding Bevel Pinions when grinding Top Face

plugs as shown, and there are additional plugs in the block *A* that act as guides for the pieces and prevent them from contacting with each other. The capacity of this chuck is 45 jaws, and the production is 125 per hour, grinding both sides from the rough forging and removing 1/32 inch of stock from each side.

Magnetic Fixture for Holding Plane Irons

A simple but effective type of fixture for holding blades for carpenters' planes is shown in Fig. 11. In this case the work-holding fixture has slots milled in it converging toward the center, in which the plane irons are laid. These slots are recessed at the front edge to form a screwdriver slot for removing the work from the fixture after the magnetic current has been turned off. The slots in the fixture, of course, are machined to the required taper on the blade and the width of the slot is such that the blade can be easily slipped in and is kept from moving endwise by two stop-pins. The capacity of this fixture is twenty-seven irons on a 30-inch chuck.

Magnetic Fixture for Holding Bevel Pinions

An interesting type of fixture for holding bevel pinions for automobile differential gear mechanisms is shown in Fig. 12. This fixture is more elaborate than any thus far illustrated, and consists of a holder *A*, which completely surrounds the chuck and is bored to receive the bronze bushings *B*. This holder is so arranged that two rows of work can be held. The bronze bushings bear down on steel plugs *C*, the latter having a shoulder, as illustrated, and resting on the chuck face. The upper ends of these studs are machined to the size of the hole in the work so that the latter fits over them. The upper ends of the bronze bushings *B* are also machined to suit the shape of the rear face of the pinions. This chuck is so constructed that the studs are in contact with one pole of the chuck while the supporting plate *A* is in contact with the other, the stud and plate being separated by a non-magnetic material as shown. The effect of this arrangement is to hold the pinions securely in place on the studs and also on the supporting plate. By way of explanation, it may be stated that this illustration shows the fixture applied to an older type of Blanchard magnetic chuck, but the same arrangement, of course, can be used on the later type of chuck.

Fixture for Holding Work Square on Blanchard Surface Grinder

The Blanchard vertical surface grinder can be used with satisfactory results for grinding strips or other work having one or more sides square with a previously finished surface. A simple fixture for handling this work is shown in Fig. 13. A number of strips of steel are placed on the chuck in the manner illustrated, and then the work is located between these strips so that, in addition to being prevented from shifting, it is held square with the surface of the table. The magnetic current holds the entire mass of pieces firmly to the face of the chuck. It is not essential that the work bear evenly on its lower surface against the chuck, as the strips against which it is held prevent it from tipping. This particular fixture was used for grinding die parts, and the parallels were made from cold-rolled steel, pack-hardened and then carefully ground.

Magnetic Fixture for Holding Connecting-rods

An arrangement that can be used for holding connecting-rods when grinding the bearing faces is shown in Fig. 14. The small ends of the rods are thicker than the large ends, and the chuck is entirely cut away in the center, as illustrated, to concentrate the magnetic current at the large end of the rod and so that the projecting bosses on the smaller end will clear. It is evident, of course, that the wheel in this fixture only comes part way in over the chuck—just enough to cover the bearing surface being ground. There are two means of holding these pieces to the chuck; they can be held by brass plugs attached to the chuck face and fitting in the hole in the large end of the rod, or they can be located by loose pieces of flat steel, which are laid on the chuck face between the pieces of work. The latter method is sometimes preferred, as it makes it much easier to clean the face of the chuck, the bronze plugs, of course, being permanently attached.

Magnetic Fixture for Holding Steering Gears

A simple but effective fixture for holding steering gears when grinding the top face at right angles to the shank is shown in Fig. 15. This is made of cast iron and is located on the chuck by means of straps as illustrated. The work is

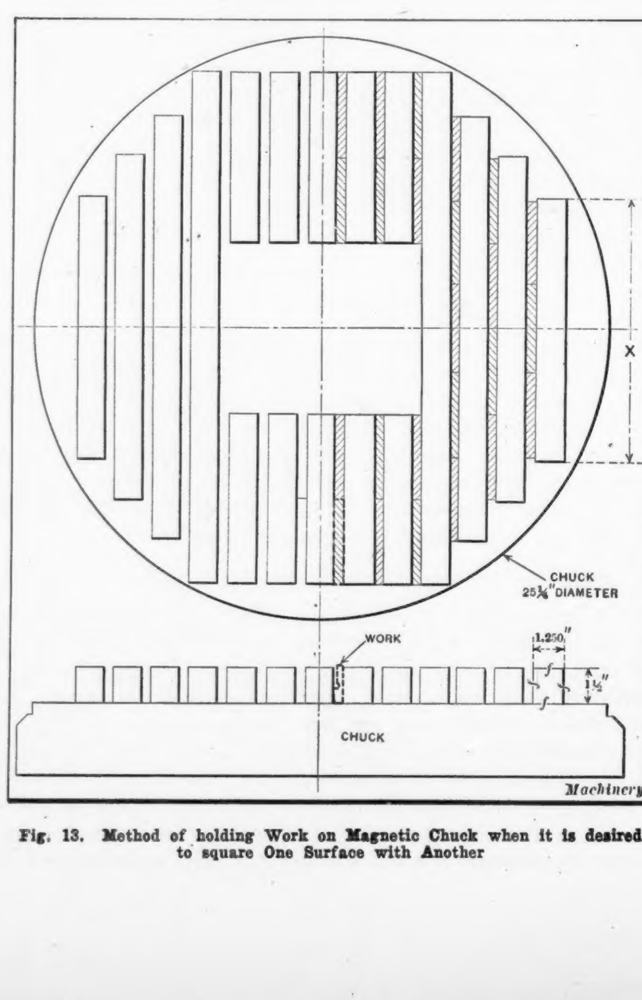


Fig. 13. Method of holding Work on Magnetic Chuck when it is desired to square One Surface with Another

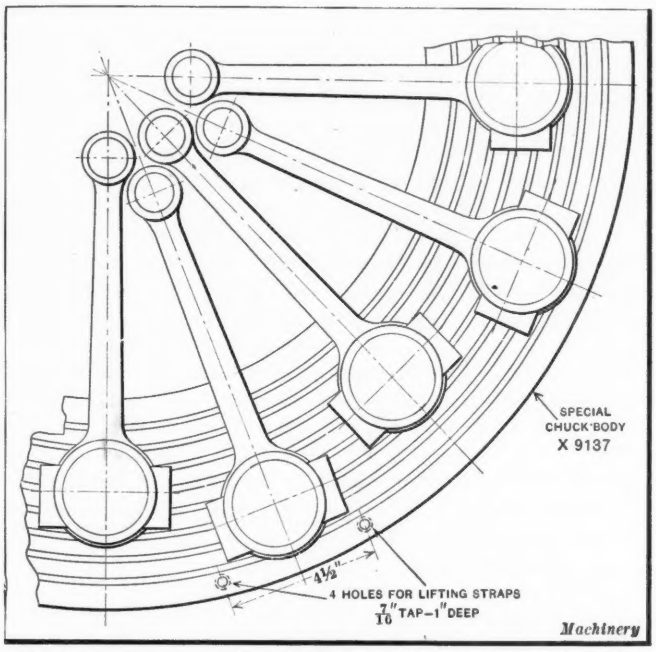


Fig. 14. Arrangement used in holding Connecting-rods for grinding Sides of Bearings

simply dropped into the holes in the fixture, the latter being made to fit the shank of the worm-wheel. The fixture can be held either by magnetism or by its own weight, the straps shown preventing it from shifting. This fixture holds twenty-one worm-wheels with shafts 1⅛ inch in diameter by 5½ inches long. The surface to be ground is 2 inches outside diameter, and 0.030 to 0.050 inch of material is removed. The production is 1000 pieces in ten hours, and they are ground to an accuracy of 0.001 inch.

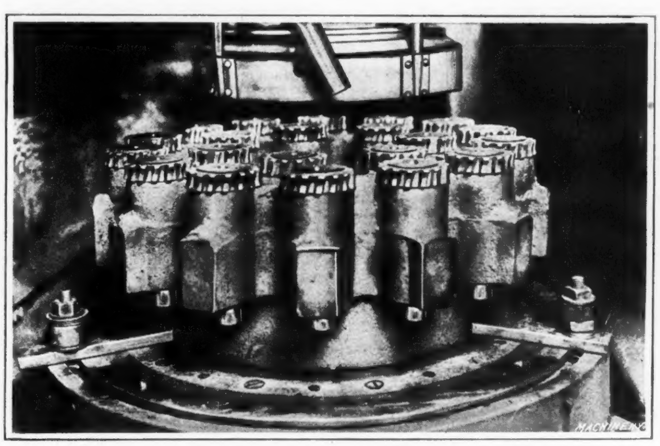


Fig. 15. Special Fixture for holding Steering-gear Worm-wheels

Fixtures for Holding Push-rods

Figs. 16 and 17 show two types of fixtures for holding valve push-rods when grinding the ends. As a rule, three or four duplicate fixtures are provided, so that a boy can load one while the other is on the machine. In this way the machine can be kept in practically continuous operation, except for the short time necessary to remove and replace the fixture. Referring to Fig. 16, it will be noticed that the push-rod here shown is ground on the large end only. The fixture consists of a ring *B*, having V-slots on both inside and outside surfaces in which the push-rods are held by means of clamping blocks. As it is necessary to locate the rods from the small end, another stepped ring *A* is used at the bench for convenience in loading ring *B*. For the grinding operation, the lower ends of the rods rest directly on the chuck of the grinder, being maintained in a vertical position by ring *B*, to which they are clamped, while three stop-blocks on the chuck (not shown in the illustration) serve to center ring *B*. The capacity of the fixture is 104 rods. When such a fixture is to be used continuously, all locating and wearing surfaces should be of hardened steel; otherwise accuracy cannot be maintained.

The fixture shown in Fig. 17 differs from that shown in Fig. 16 in that it is arranged to grind both ends of the push-rod. This fixture has previously been described in MACHINERY,[1] and is reproduced here to illustrate how a push-rod can be held so that both ends can be ground. The capacity is 104 push-rods, and the production 700 per hour, grinding both ends and removing approximately 1/64 inch from each end. Three fixtures are used, two being on the loading bench while one is in the machine.

One of the chief advantages of the Blanchard vertical surface grinder is its unlimited capacity for holding a variety of shapes of work and grinding them to the required degree of accuracy. It is evident, of course, that with a carefully designed fixture, taking ordinary precautions in keeping the chuck clean, it is possible to hold a large number of pieces to within very close manufacturing tolerances; owing to the

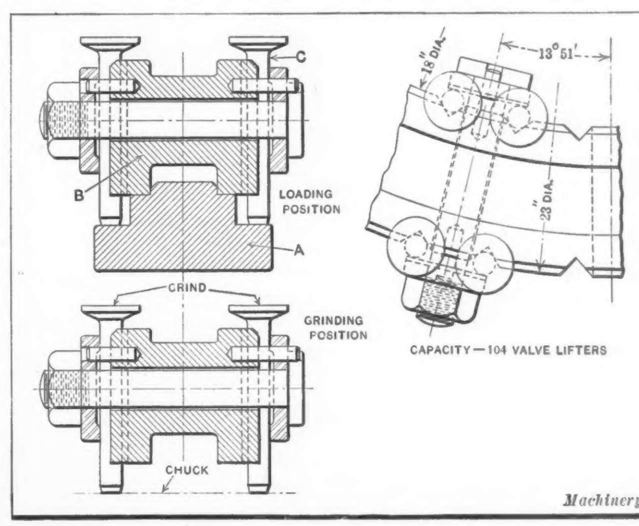


Fig. 16. Clamping Fixture used on Blanchard Vertical Surface Grinder for holding Valve Push-rods

fact also that a large number of pieces can be ground at one setting, the manufacturing costs are greatly reduced.

* *

It is stated in *Industritidningen Norden* (Stockholm, Sweden) that since the beginning of the war not less than 20,000 war invalids have been systematically trained in Germany as oxy-acetylene welders. It has been found that welding is one of the occupations which is especially suitable for men who have been maimed in the war. The rapidity with which Germany has applied itself to the task of training those who have been injured in the war, so that they may be useful in after life, and the development that has been made in the manufacture of artificial arms and hands for the injured is remarkable.

[1] See MACHINERY, September, 1915, page 39.

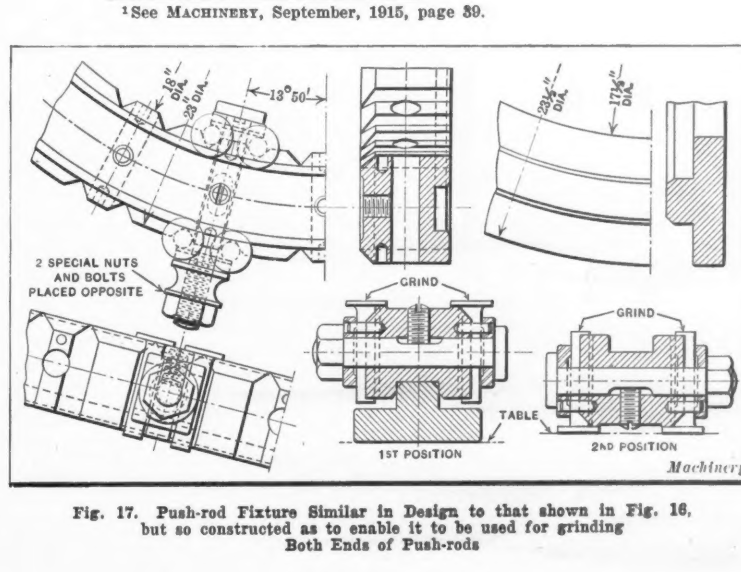


Fig. 17. Push-rod Fixture Similar in Design to that shown in Fig. 16, but so constructed as to enable it to be used for grinding Both Ends of Push-rods

FLUTES IN A HOB[1]

RELATION OF FLUTES IN A HOB TO RESULTS OBTAINED—THEORETICAL CONDITIONS NEVER OBTAINED IN PRACTICE

BY JOHN EDGAR[2]

When designing a hob, after the specification of worm or gear has been considered, probably the question of how many flutes to cut is the most difficult to treat in a general way. This has usually been treated as an arbitrary quantity, so that there is a great variation in the number of flutes cut in hobs of practically the same specifications in other respects. Although this question has been discussed before, a more thorough study will reveal something of interest to those who use hobs or have at any time the proposition of designing a hob suitable for some particular job. Some of the theories presented are not altogether suitable to the practical work of the shop because of the limitations that hem the shopman in on every side and seem to contradict theory in its application to everyday work. When considered from a purely theoretical standpoint, it is thought necessary to have an infinite number of gashes in the hob; this is exactly opposite to the practical point of view, as the life of the hob depends on its having as few gashes as will give the nearest approach to the theoretical tooth shape and still allow of the maximum number of sharpenings.

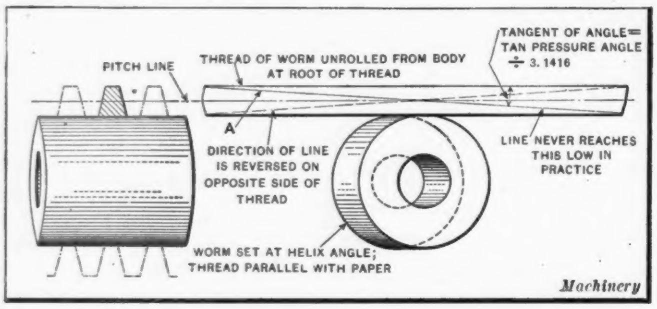


Fig. 1. Theoretical Bearing on Worm Thread

If a worm that has been run in action with the mating worm-gear is examined, it will be found that the bearing on the side of the threads of the worm does not cover the whole surface of the thread, but will show a spiral course, and if this thread is unrolled from the worm it will appear as at A, Fig. 1. This bearing, which in practice has a width greater in the middle of the worm than near the ends of the thread, is in theory a line and is made up of a series of points. The positions of these points gradually change from top to bottom, or from bottom to top, as the worm rotates; and in a single-thread worm, each point on the thread corresponds to a single point on each tooth of the gear. These points on each tooth of the gear are in exactly similar positions, and each point on the thread of the worm comes into contact with the corresponding point on each tooth of the gear, no matter what the number of teeth may be. That part of the thread that lies outside of this line of contact has, in theory, no reason for being, other than as a support, and if removed, would not interrupt the continuous rolling action of the worm and gear.

The foregoing proposition will be more easily understood if we consider a worm-gear of infinitely small width of face, which would result in purely point contact in the axial plane of the worm. If an axial section of the worm and gear is taken and the points of contact in this plane are connected by a line parallel to the plane, as in Fig. 2, the pressure line of the teeth will be obtained; and if the thread is of involute section, the pressure line will be straight. All contact between the teeth occurs on this line and is limited to that part of the line that lies between A and B. Just as the line in Fig. 1 is built up of points of contact, by rotating the worm and following the course of these points of contact as they appear in the axial plane it will be seen that the pressure line is built up of these points of contact and that they follow along this line and coincide with the corresponding point on the tooth of the gear. It can then easily be imagined that each point of contact is a diamond-pointed tool that has a reciprocating motion perpendicular to the axial plane and working at such a speed that the strokes are at close enough intervals to shape the teeth of the gear as it rotates in the proper relation to the movement of the tool-slide in the axial plane along the pressure line AB. This is a type of generating mechanism that, to the writer's knowledge, has not been used in practice but is theoretically correct in principle.

In Fig. 2, points A and B are the limits of contact. The distance from A to B projected on the pitch line limits the length of thread in contact. (In a hob this is the limit of generating action; in practice this limit is not approached.) C and C_1 are points of contact on opposite sides of the teeth. Lines drawn through the points and intersecting the pitch line at the pitch point P are known as pressure lines.

If the diamond point is replaced by a broad pointed tool, the face of which is perpendicular to the line of progress, it will be observed at once that the infinitely great number of strokes that the tool was required to make in the former case is now unnecessary, as the increased width of the tool allows of a greater interval between the strokes and the point of contact may become a line of considerable length. The outline of the gear tooth then becomes, not a curve made up of an infinite number of points, but a definite number of tangents to a curve. If the strokes of the tool are so controlled, these tangents will be of equal length from root to tip of the tooth; this would be accomplished by a constant feeding motion of the slide along the line AB. Now if the tool edge is made long enough to reach from top to bottom of the imaginary worm thread and is fed parallel to the axis of the worm by infinitely small increments, as the worm-gear is rotated in proper ratio, it will be found that the gear tooth can be formed as easily as before, but the cutting point of the tool will shift along the edge from the root to the tip, or *vice versa*, being always at the intersection of the pressure line and the cutting edge. If the thread in Fig. 1 is divided into equal parts and a cutting edge is placed at each division, a condition will be obtained that will answer as well as the latter supposition. These cutting edges are necessarily limited in location to the plane of the side of the thread. This condition is obviously what is found in the hob, the cutting edge being formed by the flute. This edge is relieved by forcing the thread tool in toward the axis of the hob as the latter revolves, giving an eccentric relief that allows the teeth formed by the gash to be sharpened without affecting their shape or size.

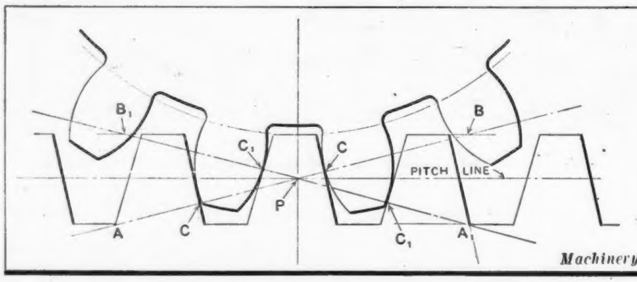


Fig. 2. Diagram showing Pressure Line, or Line of Contacts

The problem before us involves the spacing of the cutting edges so as to obtain the most practical condition, which will balance the shape of the gear tooth to be produced against the life of the hob. It has always been the writer's contention that the most practical hob was one that had very few gashes, or flutes, since the distortions in hardening counteract any gain that might possibly be had by a greater number of flutes, as the distortion is directly proportional to the number of teeth subjected to it; also, that the finer teeth, being more slender, are subject to this distortion to a greater degree than those

[1] For other information on this subject, see "How Many Gashes Should a Hob Have?", in the January, 1909, number of MACHINERY.
[2] Address: 509 N. Church St., Rockford, Ill.

of the stouter proportions found in hobs with fewer flutes. Then, again, there are conditions of operation that counteract any gain there might be in having an abnormal number of flutes. Even hobs that have the teeth ground to remove any distortion of hardening and manufacture are subject to conditions of use that go far toward nullifying the prospect of fine finish with the greater number of flutes.

Minimum Number of Flutes in Hob

To find what may be deemed a minimum number of flutes, the significance of the tangents that are directly proportional to the number of flutes will be analyzed. This condition of direct proportion is often defeated in cases where the distortion of hardening is excessive or in case of careless sharpening. When the tooth of the gear appears with tangents of quite noticeable irregularity, this condition cannot, of course, be taken into consideration.

The rolling action of the worm-gear on the worm is analogous to that of the spur gear and rack, the rack being represented by the axial section of the worm and the spur gear by a worm-gear of very narrow face. The successive positions of the rack teeth may be represented by rotating the worm until each radial plane is brought into coincidence with the axial plane and registered. This has been done in Fig. 3, where each radial plane represents also one flute in a hob of the same pitch and proportions as would be used to hob the gear. It will be found that the pitch of the worm is divided into as many equal parts, or divisions, as there are radial planes, so that the number of positions assumed by the rack in each revolution of the worm is equal to the number of radial planes. It will also be found that the distance between each division is the pitch divided by the number of radial planes, or flutes, of worm or hob, respectively. Since the gear rolls on the pitch line of the worm, the pitch circle may be divided into spaces equal to the divisions on the pitch line of the worm. Each division will then represent an angular advance of the gear corresponding to the lateral movement of the thread section of the worm on the axial plane, and an equal advance by the imaginary rack.

In Fig. 4, these equal divisions have been spaced off, the space from one radial plane to another on the worm being equal to the lead of the hob divided by the number of flutes. This diagram shows that, in this case, twenty-two teeth generate the involute part of the tooth curve, there being twelve flutes in the hob. If the rack is rolled on the gear, it is obvious that the pressure line will always be perpendicular to a line drawn through the point of tangency of this line on the base circle, which is drawn tangent to the pressure line, with the axis of the gear as a center. Drawing a line to represent the pressure line at each position of the rack, when rolled on the gear, gives the series of tangents shown in Fig. 4. These tangents divide the tooth curve into unequal divisions, the distance between which gradually increases as the divisions near the point of the tooth. The distance varies almost in proportion to the distance from the point of tangency on the base circle; that is, it increases as the curve flattens out. Obviously, the point that governs the number of these tangents is the width of the tangent at the pitch point, as there the teeth roll on each other, and any condition that will answer there will be likely to answer at any other point on the tooth.

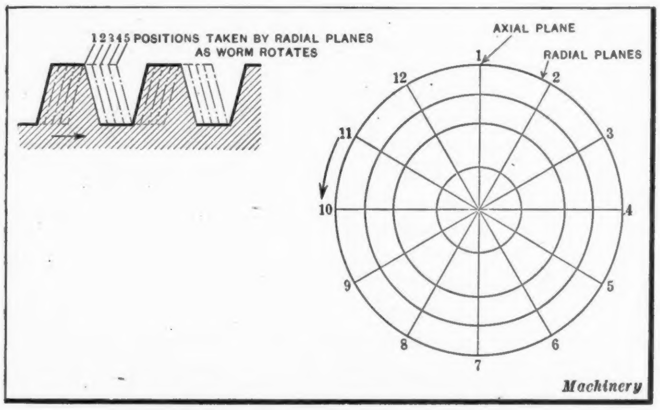


Fig. 3. Radial Section on Axial Plane and Successive Positions of Rack advancing in Direction of Arrow registered at Regular Intervals

From a lay-out similar to Fig. 4, it will be found that a width of tangent of 0.0625 inch in a tooth of one diametral pitch on a gear of twelve teeth will not be excessive or noticeable. The width of tangent at the pitch point on all gears cut with a hob of the same number of flutes will be equal. If the radius of the curve is taken as equal to the length of the pressure line between the curve and the point of tangency (and it will closely approximate this for so short a length as is being considered), it is possible to arrive at a close approximation of the depth of this tangent, as it differs from the curve it replaces, and so convince ourselves that the substitution is well within the limits of good practice. In the case of the twelve-tooth gear and a pressure angle of 14½ degrees, the

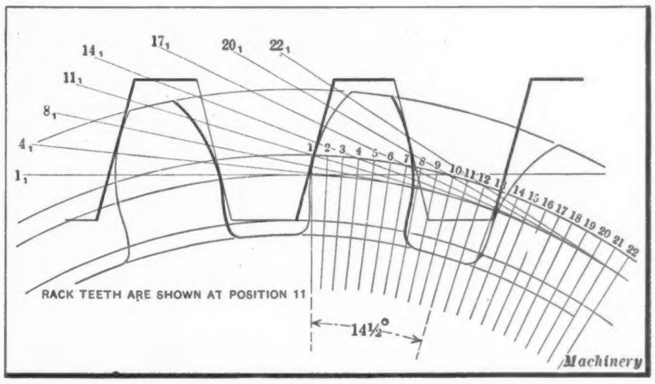


Fig. 4. Relation of Pressure Line to Tooth Curve

radius of the curve may be said to equal the pitch radius of the gear multiplied by the sine of the pressure angle, or in this case, 1.5024 inch.

The depth of the "flat" is found by the modified formula for the rise of an arc:

$$H = F^2 \div 4R$$

where H = depth;
F = width of flat or tangent;
R = radius of tangent circle.

The depth in this particular case is 0.000333 inch. This seems to be a passably close approximation to the curve, as this depth could not be the cause of any great difference in the rolling of the gears. The depth of the tangent at the pitch point varies inversely as the number of teeth in the gear, so the question arises: What number of flutes will produce this result? In a 14½-degree involute, the spacing of the pitch line will be approximately four times that on the curve at the pitch point, or the spacing on the pitch circle will be $4 \times 0.0625 = 0.25$ inch, approximately, since the pitch circle is divided equally into as many spaces per inch as the pitch line of the imaginary rack. As these spaces result from dividing the lead of the worm equally into as many spaces as there are cutting edges per convolution of thread, by reversing the operation the number of radial divisions in the hob is found to be $3.1416 \div 0.25 = 12.56$, or, say, 12, as an even number. This number would be as suitable for any pitch, for in the finer pitches the depth and width of the tangent decreases in direct proportion to the diametral pitch of the hob. The use of a smaller number of teeth in the hob, say ten, is permissible, as the error is only slightly greater than with twelve teeth, and in finer pitches would not be noticeably greater. In a general way, twelve teeth may be considered a good standard for spur and spiral gear hobs with a little leaning toward a smaller number of flutes.

Multiple-thread Hobs

In worm-gear hobs, conditions that limit the number of teeth or flutes are often met, so that the foregoing recommendation cannot be put into practice. For instance, the diameter and pitch of the worm may be such that a much smaller number of flutes will be found necessary to obtain the required strength of tooth. Many worm hobs with five or six flutes are found that seem to answer the requirements fully, while

others would give better results if the number of flutes were greater. Checking back in the manner just explained, figures would be found that one would doubt as being practical, the tangent being so wide, but when it is realized that the results obtained are giving satisfaction a person feels justified in recommending a small number of flutes. Such conditions as these should not be allowed in the case of spur-gear hobs, as that would be carrying the matter too far; but the writer knows of many cases where multiple-thread hobs with twelve flutes are used with good results. Such a hob has but six working flutes per thread. Multiple-thread hobs are being used extensively in finishing spur gears. To get as good results as with a single-thread hob of the same pitch, other conditions being equal, they should have the number of flutes that one would give a single-thread hob times the number of threads; thus, a double-thread hob should have twelve flutes per thread, or twenty-four flutes in all.

In using multiple-thread hobs for spur- and helical-gear finishing, the hob must be so proportioned that there are enough flutes per thread to give a good substitute for the theoretical tooth shape. This is obviously possible in only the smaller pitches; coarse pitches should not be handled this way. There are conditions of manufacture and use that enter into the proposition of getting good results from multiple-thread hobs that are not encountered in the case of single-thread hobs.

In the case of the single-thread hobs, there is no relation between the number of flutes and the number of teeth cut. Each tooth is produced by exactly the same action and by the same teeth of the hob, so that each tooth must be an exact duplicate of its mate. This is not the case in gears cut by multiple-thread hobs. Here the number of teeth is divided into groups, there being a group for every thread in the hob when the number of teeth in the gear is divisible by the number of threads. If the number of teeth in the gear is prime to the number of threads, the teeth in the gear are acted on by all the teeth in the hob, which produces the effect of a hob with twice the number of flutes as in the former case. This has produced the theory that the flutes in multiple-thread hobs should have a number prime to the number of threads. This theory is, of course, based on perfect conditions, but these conditions are so rarely met in practice that nothing would be gained by having such hobs. Were it possible to obtain a hob that did not vary in any degree in the spacing of the threads nor in the teeth as they come into the generating position, the teeth in the hob, having a number of flutes prime to the number of teeth in the gear, would not track, but would split the tangents into narrower tangents, thus producing a better approximation of the true involute. But since these conditions are never obtained in ordinary practice, it is desirable to employ the simpler methods of manufacture involved in making a hob with a divisible number of flutes, it being possible to obtain better results in this way than otherwise.

A mention of some of the difficulties encountered in making a hob with the number of flutes prime to the number of threads will show the wisdom of avoiding that condition whenever possible. Most multiple-thread hobs have a thread of considerable

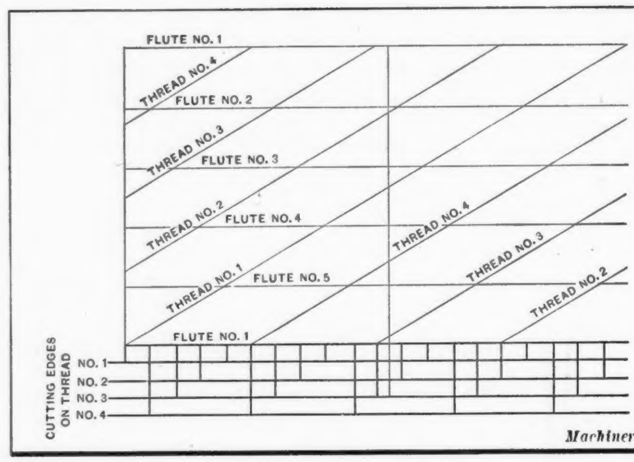


Fig. 6. Development of Cutting Edges of Five-fluted, Four-threaded Hob

angle, and so are fluted spirally, making it more difficult to index the thread than were the flutes milled axially. The odd number of flutes to the number of threads complicates the indexing, as the relation of tool to flute is thrown out when the hob is indexed to bring the next thread to the forming position. This makes it necessary to reset the tool or perform another differential indexing operation to bring the tool back into proper relation with the flute in the hob. This multiplicity of operations cannot be performed without a long chance of error in the spacing of the thread. The error thus introduced may be sufficient to counteract any advantage gained by the prime relation of the flutes to the threads, as it results in a thick thread that will eradicate the work of the other thread when it passes through the tooth already formed by that thread. When the number of threads in the hob is divisible into the number of teeth cut, the result is thick and thin teeth. When the number of flutes is even to the number of threads, the indexing of the hob in forming the threads is a simple one-operation matter, and absolute accuracy is more nearly assured.

It is when the use of the hob is considered that conditions counteracting any gain that could result from the prime relation of the threads and flutes are met, for even with a hob that is absolutely perfect in both design and manufacture, the conditions surrounding its use are never so nearly ideal. Even if the hob is in perfect condition and has been carefully sharpened, the proposition of placing it on the hobbing machine so as to run perfectly true is not so easily accomplished, and a very small amount of runout will counteract the slight gain that might otherwise be realized with the hob of prime relation. A very slight runout results in a condition similar to that obtained with a hob having a thick thread and gives a gear with thick and thin teeth, when the number of teeth is even; and a rough surface on spiral and helical gears, if the number of teeth is prime. Where the number of flutes can be made reasonably numerous, so that the tangents, when investigated as just described, are not of excessive width, the "prime relation" in the hob is to be avoided.

Conditions Making a Prime Number of Teeth in Hob Advisable

There are cases where it may be advisable to consider the use of the prime relation hob, such as where the lead is great and there are more than two or three threads. For example, suppose that the maximum number of flutes obtainable is five, because of the small diameter of the worm and the steep lead; that there are four threads; that the thread section is standard, that is, the working depth is 0.636 $\times$ the pitch; and that there are seventeen teeth in the gear.

In Fig. 5, the tooth shape of this gear is shown. Here *ABC* is the flat produced by one thread on a four-thread, five-flute hob in a gear of seventeen teeth, and shows the shape of tooth produced at one revolution of the worm-gear with the hob cutting the full depth for one revolution of the work. The equal spaces 1_1-5_1, 1_2-5_2, etc., corresponding to the cutting planes of the hob are laid off on the pitch line and the tangents to the tooth curve relative to one thread are shown. This condition

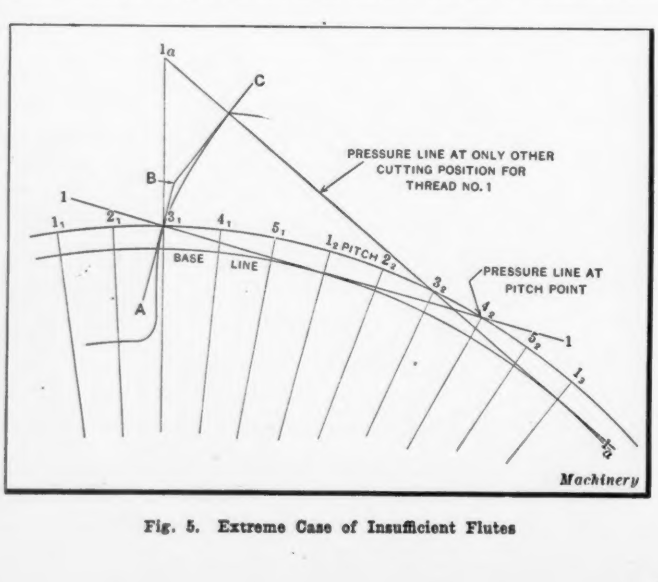


Fig. 5. Extreme Case of Insufficient Flutes

shows that if the teeth in the gear are a multiple of the number of threads, the junction of the two flats produced by the only cutting edges—there being but two in this case—will leave the hump as at *B*. Therefore, a hob of such extreme proportions would be a failure, and the only remedy would be to have more teeth or use some of the hobbing systems where the hob is moved along on its axis in proper relation to the rotation of the gear so as to produce a better approximation to the theoretical curve.

In the case of the gear having a number of teeth that is prime to the number of threads, the threads alternately pass through the spaces between the teeth, and by reason of the flutes of the hob being prime to the number of threads, the teeth of the hob do not track. Each tooth strikes the tooth curve at a different angle, and the tangents produced, therefore, blend into one another and a close approximation to the true involute curve is obtained. This only applies to those gears that have a number of teeth which is odd to the number of threads in the worm. If the number of teeth in the gear is not a multiple of the number of threads, but is even when the threads are even, the number of tangents obtained on the tooth curve is only a fraction of that obtained when the teeth are odd to the number of threads, or *vice versa*. In the present example, if the number of teeth should happen to be even, but not a multiple of the number of threads, the number of tangents will be only half the number obtained when the teeth are odd. A number of combinations can be obtained, depending on the number of threads in the worm and the number of flutes in the hob.

A diagram like that shown in Fig. 6 will reveal many interesting facts if studied in connection with the design of the hob for such extreme cases as those being considered. It not only shows the number of cutting edges there are in the hob, but also whether or not they track. The diagram is constructed by laying out the pitch of the threads on the horizontal lines and the pitch of the flutes on the vertical and then drawing the threads at the proper angle from the points laid out on the horizontal. The points of intersection of these lines will be the location of the cutting edges. The cutting edges in rows 1, 2, 3 and 4 act on the first, second, third and fourth teeth of the gear, respectively, when the number of teeth is a multiple of the number of threads. Cutting edges in rows 1 and 3 and 2 and 4 act alternately on every other tooth when the number of teeth is even but not a multiple of the number of threads. Cutting edges in rows 1, 2, 3 and 4 act on all the teeth of the gear when the number is odd.

In conclusion, it may be said that for spur and helical gears, when the hob is used on standard hobbing machines, the hob should be designed with ten to twelve flutes. In cases where the conditions are special and require holding a given diameter, the number of flutes should be determined by the methods just explained, the tangent being held within limits of 0.075 to 0.050 divided by the diametral pitch of the gear. In cases of multiple-thread hobs, the prime relation should be avoided, the threads being equally divisible into the number of flutes. When, however, the prime relation has to be employed, the following rule should be observed: If the number of threads is even, the number of teeth in the gear and of flutes in the hob should be odd; if the number of threads is odd, the number of teeth and flutes may be odd or even, but not multiples.

Many hobs are now in use that would be much better producers, so far as quality of product is concerned, had the prime relation been avoided. They were designed (or shall we say laid out?) according to rule, without proper insight into the limits of practical conditions surrounding their manufacture. Many purchasers of hobs would do well to take the manufacturer into their confidence in the design of their hobs and not insist on stated specifications, which are only a drawback to efficient hobs that can be made accurately and give perfect satisfaction in every way if these restrictions that make it difficult to give good service are avoided. All the flutes that can be crowded into a hob will not give good gears unless intelligent use and proper upkeep enter into the proposition.

COMPOSITION AND CHARACTERISTICS OF EXPLOSIVES

BY A. SCHLEIMER [1]

Perhaps no one class of articles at the present time is attracting as much attention as explosives, but the only one familiar to most of us is the old black gunpowder. This has been in use since the middle of the thirteenth century, and while the origin is not known, it is generally attributed to the Chinese. Its composition today is practically the same as it was then, the difference being only a matter of proportion. As made today, the powder is 75 per cent potash nitrate, 10 per cent sulphur, and 15 per cent charcoal.

Practically all the higher explosives are based on "nitro," which is a chemical combination of glycerine and nitric acid, wherein the three hydroxyls of the glycerine are replaced by nitrogen oxide or some other organic substance with which the nitric acid can combine in a similar manner. The first step in the manufacture of nitroglycerine is making the mixed acid. This is a mixture of nitric and sulphuric acids with a small percentage of water, in definite proportions. The acids are mixed in a large vat by means of compressed air, and cooled. The glycerine is warmed sufficiently to overcome its viscosity, and carefully added. The temperature at this stage of the process is a most important factor, and is controlled by a coil in the liquid. When the reaction is complete, the nitroglycerine is run off and washed thoroughly with water and alkali in order to free it from all traces of free acid. This forms what is known as trinitro-glycerine, which is the true chemical name, as distinguished from other combinations of nitric acid and glycerine, of which there are a number; this, however, is by far the most important one. The sulphuric acid in this instance has no chemical significance whatever, its action being purely catalytic. After the nitroglycerine has been removed, concentrated acid is added to the mixed acid, which is used over again. The "spent" mixed acid contains considerable nitroglycerine, which is recovered by diluting with water, heating, and agitating, which causes the nitroglycerine to separate.

Nitroglycerine is a heavy, thick, syrupy liquid. It has a specific gravity of 1.6, and its melting point is 13 degrees C. It has an intensely sweet taste, but is very poisonous, even in small quantities, when taken internally. The dose, when given internally, is only from 1/200 to 1/50 drop. Nitroglycerine is very sensitive to shock and friction, for which reason it is dangerous when frozen, as it must be thawed out before it can be used. It is only within the last few years that a diluent has been found that will lower its freezing point without impairing its explosive power.

Dynamite

Dynamite is simply nitroglycerine to which an absorbent has been added in sufficient quantity to form a solid mass, such as diatomaceous earth, clay, ashes or carbon. It is important that the adulterant have the correct absorbing qualities, for an excess of nitro will naturally exude, while if the absorbent is in excess, it is likely to crumble. Either condition is likely to give serious trouble at some unexpected moment. Both nitroglycerine and dynamite are particularly dangerous, owing to their instability. One can never tell just what they are going to do. The slightest shock will frequently be sufficient to explode them; consequently, the greatest care is necessary in their handling and transportation. On the other hand, there are many cases on record where the sudden application of great shock has had no effect. In one case a truck loaded with dynamite broke down and the load rolled down a short, steep hill, after falling off the truck. In another case a large ammunition plant, several years ago, was practically demolished. The explosions, as the buildings were destroyed, were so great that they were plainly heard fifty miles distant, and hundreds of windows were shattered in nearby towns. Yet the nitro house, which at the time of the explosion contained four tons of nitroglycerine, was not destroyed.

In making dynamite, the absorbent is first mixed by hand

[1]Address: Rutherford, N. J.

and then passed through a sieve; the care necessary can readily be understood when it is realized that a spark will set it off. This makes the use of machinery for mixing very dangerous; for, while it is easy to make machinery that will do the required work as long as it remains mechanically exact, the dropping out of a screw or the chipping of one of the blades or other parts while in operation is likely to cause a spark, which means disaster and loss.

Dynamite can easily be exploded by a blow. A small quantity can be ignited and burned with impunity, but larger quantities, if ignited, will be exploded by the heat generated. When frozen, dynamite is exceedingly dangerous and likely to explode by force of fracture. When brought into contact with water, the nitroglycerine readily separates from the absorbent, and for this reason precaution is always taken to keep it dry. To overcome this, the absorbent is sometimes replaced by collodion, forming the so-called blasting gelatine, or gelatine dynamite. This class of explosives has the advantage of being more stable for transportation purposes. On the other hand, it is more dangerous to make, as it must, of necessity, be mixed by machinery. Wood is used in the machinery wherever possible, and iron and steel are replaced by softer metals, lead, brass and zinc, which are not so likely to spark when struck. The mixing tanks are fitted with connections for hot water, in order to raise the temperature to the proper degree, as well as for cold water, to be used should the temperature rise too near the danger point, which it has a tendency to do. While in the "doughy" condition, the mass is run through a continuous screw machine similar to the ordinary household meat chopper, which turns it out the required size, after which it is dried and cut.

There are quite a number of different nitrocelluloses. The one used for the manufacture of high explosives is the trinitro, which is not the same as the dinitro used for making commercial collodion. The dinitro, while not so highly explosive as the trinitro, is sufficiently dangerous to warrant no undue unfamiliarity. Starch, which is so closely allied to cellulose chemically, is also used to a great extent for making blasting powder, by treatment similar to that used for nitroglycerine and guncotton. When wet, guncotton is quite harmless, though when mixed with some that is dry, it can be exploded by means of the dried. Blotting paper, tissue, wood-pulp, rag and other paper have all been discarded in the manufacture of guncotton for high explosives, and only cotton cloth is used in the form of rags or waste. The structural changes taking place in cellulose do not, however, affect its solubility, and for this reason any form of cellulose may be used for the manufacture of such products as collodion, celluloid, etc.

In the factory, the cotton waste is first hand-picked to remove the greater part of the mechanical impurities, such as pieces of wood, metal, rubber or whatever it may contain. It is then run through a teasing machine, which opens the knots, lumps, etc., and separates the fibers to permit of easy and rapid absorption of the acid. It is afterward run through a drying machine, which removes all but about 1 per cent of moisture, and this is taken care of by the sulphuric acid. The cotton is then nitrated in earthen pans, being added to the acid slowly and carefully, a small quantity at a time, so that the acid may permeate it thoroughly. After it has all been added, weights are placed on the cotton to keep it below the surface until the action is complete. The time required for nitration depends on the temperature, the strength of the acid and the dryness of the cotton. The greater part of the waste acid is run into a storage tank, where it is revivified by the addition of concentrated acid and used over again.

A thorough washing of the cotton is necessary after the acid treatment, as it must be absolutely free from any trace of acid. In some cases an alkali wash is used to counteract the acid, and then the cotton is washed to free it from the alkali. This is not advisable, however, as the cotton is likely to suffer from the chemical action of the alkali, which causes hydrolysis to a greater or less degree. The nature of the water used must also be taken into consideration.

After the final washing and drying, the cotton is placed in a machine, where it is treated to loosen and tear the fibers apart, and in this way whatever impurities remain are removed. For certain kinds of work, however, the cotton is formed into cylinders or slabs, while still damp, and then dried, which facilitates handling, as the cotton is less dangerous when moist.

Picric Acid

Picric acid, which for years has been used for coloring purposes, is one of the later explosives. Chemically, it is a relative of nitroglycerine, being a trinitro-phenol, whereas nitroglycerine is a trinitro-glycerine. It is a powerful explosive with a very high melting point; so high, in fact, that it must be adulterated to bring its melting point down in order to make it of practical value. Picric acid is one of the most dangerous explosives to handle or manufacture. It readily attacks most metals or their oxides, combining with them to form metallic picrates, which are as "ticklish" and uncertain as the well-known fulminates. For this reason it is not allowed to come in contact with metals, and shells in which it is used must be waxed or shellacked so that it will not contact with the metal. For this reason picric acid is used for priming more than for any other purpose. It has a tendency, furthermore, to dissociate most salts with which it comes into contact. Even the fumes arising from it in process of manufacture are deadly, and the skins of those working in it are stained a deep yellow, which is permanent. Phenol, from which picric acid is made, is the chemical name for what is commonly known as carbolic acid.

Trinitro-toluene

Trinitro-toluene is one of the most recent achievements of the military laboratories, and is probably the most commonly used high explosive today. As its name indicates, it is a combination of trinitryl and toluol. It is much less dangerous to manufacture or handle than either picric acid or nitroglycerine, as its fumes are not injurious nor is it sensitive to shock. Heat and moisture have little or no effect upon it, and it refuses to combine with the metals or their oxides. It seems rather incongruous that this substance, which is probably responsible for the greatest destruction of human life in the history of the world, is also the source of the sweetest substance known. From toluene is obtained saccharine, which is approximately five hundred times sweeter than sugar. In use, the nitro-toluene is melted and poured into the steel or iron shell, where it solidifies, and is exploded by a time or percussion fuse. The investigation and study of explosives is fascinating, and there is a wealth of information open to those who are interested.

* * *

PLATINUM DEPOSITS OF THE WORLD

The metals of the platinum group—platinum, palladium, iridium, rhodium, ruthenium and osmium—are necessary in many industries closely connected with the war. But the known supply is limited; possibly 5,000,000 ounces have been produced in the world to date, about 95 per cent of which was obtained in Russia. It is estimated that 500,000 ounces are used in contact plants for the manufacture of sulphuric acid; 1,000,000 ounces, in chemical and physical laboratories; 250,000 ounces, in electrical devices; and 1,000,000 ounces, each in jewelry and dentistry. The United States uses 165,000 ounces of platinum a year; about 45,000 ounces are used in the manufacture of sulphuric acid and about 80,000 ounces in jewelry. Of this amount, 65,000 ounces are refined in the United States and 100,000 ounces are imported. With the exception of a little platinum and allied metals obtained by refiners of copper and nickel mattes and gold bullion, all the platinum in the world has been won from placer deposits. Platinum is not known in all countries in the world, but it seems hardly possible that all the deposits of this valuable metal are known. In fact, platiniferous deposits in southern Spain have been discovered quite recently. Colombia, South America, is the second largest producer of platinum. The metal is also found in Brazil, Borneo and Australia. In North America, platinum exists in the gravels of a number of streams in the western mountains, both in Canada and the United States.—*U. S. Commerce Reports.*

USE OF OIL AS FUEL

ECONOMY—STORAGE AND FEEDING SYSTEMS—TYPES OF BURNERS

BY J. V. HUNTER [1]

A FEW months ago a visit was made to a large manufacturing plant, where the visitor is welcomed and gladly shown through the place, as those in charge feel that they have an establishment of which they can be justly proud. Like most really successful factories, it has specialized in one line of product, and it shows plainly that it is a one-man institution. The forge shop astonished the writer; it was the third that he had visited within a few months where no furnace equipment had been provided for the rapid heating of large and small metal parts by means of fuel oil. Large quantities of small steel parts were being slowly heated in ordinary blacksmith coal fires. Two small built-up brick-walled coke furnaces did a little toward speeding up the work by furnishing quantities of unevenly heated metal parts, when they were not cold from fresh fuel charges. Nor were there any gas furnaces, although this plant had its own producer plant outfit for furnishing producer gas to heat a series of enameling ovens. However, few plants have service that will justify the expenditure required for a producer-gas installation merely for heating a few furnaces, so it will seldom be found as a general adjunct to a blacksmith-shop. It does seem, however, that many factory managers have been slighting the efficiency of their forge-shop departments by failing to provide means for heating steel parts rapidly, so as to keep the workmen steadily employed.

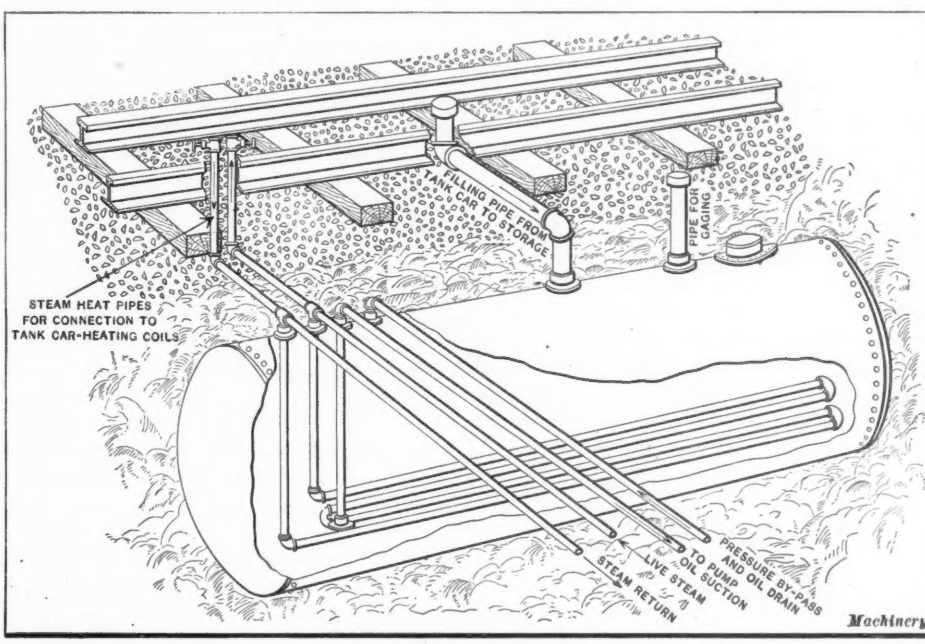


Fig. 1. Arrangement of Oil-storage System

Inquiry has almost invariably elicited the following explanation of the inattention to this phase of forge-shop efficiency: "City gas costs too much, even at a reduced price, to be used as a fuel, while producer gas is not warranted, nor could it be profitably maintained for the small quantities of gas that would be consumed. An oil system is costly to install, dangerous as a fire hazard, difficult to maintain, and unsuccessful unless installed and maintained by one who thoroughly understands its intricacies. The representations of the different oil furnace salesmen do not sound reasonable and the furnaces that they sell are very costly."

Yet if reasonable care and sensible directions are followed, all these objections can be reduced to a minimum. The cost of installation will not be great as compared with the savings that will accrue. The fire-risk will be no greater than may be expected from the sparks and live embers from a coal or coke fire. The cost of maintenance will be practically nil; a few cents a day for power, and a like amount for occasionally oiling the pump and starting and stopping the motor of the pump. Moreover, with a little study of the few simple rules or systems involved in the design of oil-heating furnaces, anyone may design and at small cost build furnaces exactly suited to the types of work that he desires to heat. Many good furnaces have been built of scrap sheet steel, angles, and bars that were lying around in the scrap yard. Many shops design or build their own furnaces and burners at from one-third to one-fourth the cost at which these could be bought. Good furnaces are the most valuable production stimulators in any forge shop. The oil furnace will add practically 50 per cent to the production that can be obtained from the customary coke or hard-coal furnace; and often at an additional reduction in the labor burden, as the coal fires require much of a helper's time for replenishing the fuel. After each charging, an appreciable time is lost waiting for the bed of coals to burn through and bring the work up to its proper heat. With an oil furnace of proper design, the work can be charged and withdrawn at a uniform rate, and an even heat maintained on all pieces.

One job of heavy hammer forging, in a western shop doing gas-tractor work, was heated on the bed of coals of a large hard-coal furnace. Because of the size of the furnace and the quantity of work to be handled, one helper was kept busy charging the coal and turning over the pieces to get as even a heat as possible (which was not very even at the best). After the installation of an oil burner, the time lost between heats was entirely avoided, and as the hammerman's helper laid in a cold piece each time that he withdrew a hot one, the furnace tender was eliminated. This change, on a day-work system, increased the production by a little over 40 per cent; later, by the establishment of premium payments on the same job, the production was increased, approximately, an additional 80 per cent. The latter increase would have been almost impossible had not the increased heating capacity made possible the handling of so much more work by the men, by the coolness of the surroundings and the rapid heating.

Cost of Oil as Fuel

Depending on the locality, the price of fuel oil in tank-car shipments will vary from a little over two cents to somewhat over four cents a gallon. Those who buy in smaller quantities, depending on the local oil supply houses for their wants, will have to pay a considerably higher price. Consequently, as a 10,000-gallon storage tank will cost about $125 in this locality, and perhaps no more elsewhere, it will pay nearly any user to equip his plant for quantity purchases.

The cost of the oil fuel depends greatly on the locality of the consumer with respect to the oil fields from which the supply will be derived. The known oil fields of this country are now so well developed and so widely scattered that the freight haul cost does not become excessive in any locality. Those who have access to the western, or Texas and Kansas, oils have an additional advantage, because these oils have little or no value for the production of lubricating oils and the other valuable petroleum derivatives, and consequently, in their crude state, are of much less value than the other oils.

Unlike coal or coke fuels, which vary widely, the oils from

[1]Address: 152 Arthur Ave., Minneapolis, Minn.

each field are almost uniform with respect to their heat values per pound. Some grades are of greater specific gravities than others, and as the price of oil is based on a "per gallon" system of measurement, a heavier oil will furnish a greater number of heat units per gallon. But a light oil can be more easily and efficiently burned than a heavier one, which offsets its lesser heat value per gallon. The range in heat values of American oils are given in Table 1. The eastern states are largely supplied with oil carried in tank steamers to their most accessible ports from the Texas fields, this being by far the most economical oil. The central states draw from the great Illinois, Indiana, and Ohio fields; the Middle West, from the Kansas region; and the Pacific states, from the asphaltic oil fields of California. When the Mexican fields were producing in large quantities, their output was largely used in Europe.

The smallest tank cars usually shipped with fuel oil contain from 6000 to 7000 gallons. Smaller cars can occasionally be obtained, but the number of these cars is very small, so as a shipper might be forced to wait some months before obtaining one, it would be unsafe to depend on such unreliable shipments. Allowing approximately 3000 gallons excess capacity to carry over any periods of delayed delivery of the oil car, it is customary to install about a 10,000-gallon tank for storage purposes.

Oil Storage Systems

Tank cars can be most readily drained by gravity, and the majority are drained in this way. An oil tank situated in a convenient position for filling from an oil tank car is shown in Fig. 1. The tank shown is of steel, but reinforced concrete has given very satisfactory service; when concrete is used the capacity of the tank can be considerably increased at little additional cost. There is at least one concrete tank in the extreme northwest, built mostly underground, that has been subject to great climatic changes without developing the slightest leakage. Needless to say, both for convenience in unloading and to meet the fire underwriters' requirements, the tank should be entirely underground. When located above ground, it should be situated at least 150 feet from the nearest building.

Tank cars are emptied through a connection, in the center and bottom of the tank. The pipe connections for emptying should be placed either between two ties in the center of the track or very close outside. An arrangement that will necessitate the laying of several lengths of pipe every time that a car must be emptied is most inefficient. The piping should be so arranged that one standard length of pipe, with an elbow for slight adjustment, will always reach the proper spot; if necessary, the car can be shifted slightly with a pinch-bar. Another plan is to use for the connection a six-foot piece of flexible oil-proof hose.

Fig. 1 shows an arrangement in which the flexible hose connection is used. All that is necessary, when making the attachment, is to remove the cap placed on the end of the upright pipe to prevent the entrance of dirt. When, during cold weather, it is necessary to heat the oil to facilitate its flow, the connections can readily be made to the steam mains provided, as shown in the illustration. Ordinary rubber steam hose should be used for this purpose. It is advisable to have this hose at least fifteen or eighteen feet long, as, unfortunately, all tank cars do not have their steam connections uniformly located; and to use pipe would necessitate cutting and fitting it for each car.

Fig. 2 shows a double underground tank installation; only

TABLE 1. HEAT VALUES OF AMERICAN OILS

Oil Field	Average Density of Crude Oil	Heat Value per Pound
Pennsylvania, heavy.......	0.886	20,736
California	0.933	18,880
Lima, Ohio, fuel grade.....	0.943	18,900
Texas, fuel-oil distillate....	0.880	18,850
Mexican	0.878	18,000

Machinery

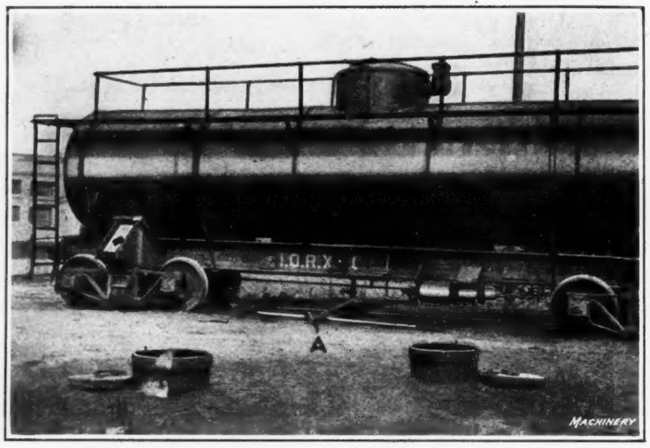


Fig. 2. Arrangement of Double Underground Tank

the manholes for inspection purposes show above ground. Ordinarily, it is unnecessary to provide such manholes; when used, their covers should be kept padlocked. With these tanks, a pipe connection *A* of standard length is provided for draining the tank car that stands on the siding. The quantity of oil in the tanks may be determined by lowering a pole through one of the manholes. In Fig. 1 the manhole opening is entirely below ground. To provide for measuring the oil in this tank, a two-inch pipe is run to a capped end above ground; this is large enough for the insertion of a rod or bar. Sometimes a tee is inserted in the filling pipe and the end of the pipe run from this is capped to prevent the entrance of dirt.

Usually, the writer has figured the capacity of the tank for each inch of height. Then taking a clean wooden rod about one inch square, he has marked upon it at each inch of its length, with quarter-inch steel numbers, the capacity of the tank at that point. A coat or two of shellac is then given to prevent the oil from soaking into the wood and obscuring the lettering. Daily or weekly readings of the tank will give the consumption of fuel, if this data is desired for cost or other records.

The winter climate in the majority of the states is sufficiently cold to reduce the consistency of most fuel oils to a very heavy grease that will not flow without warming. For this reason several loops of 1-inch steam heating pipe should be placed in the bottom of the tank and then connected to the boiler or any steam supply. A return pipe and outlet should be provided for the condensed steam. When possible, the steam pipe to the tank should be placed in the same ditch as the suction feed line from the tank to the oil pump. This will assist the flow of oil during the winter and prevent the clogging of the pipe should the frost penetrate the ground to that depth. Tees should be provided in both the live and the return steam lines, and from these branches should be run to valves above the ground beside or inside the track. The heating coils of all tank cars are provided with a steam trap at their outlet for draining out the water, so a return pipe is not absolutely necessary.

When a tank is placed in a freshly filled ditch, it should be filled with the oil soon after it is imbedded, so that there will be no chance of its floating before the ground becomes thoroughly packed about it to hold it down. The writer once sank a tank in a pit in what was a clay, fairly water-tight soil. As the filling-in of the pit was hastily done late in the evening, the filling of the tank was postponed until the next day. But that night there was a heavy storm and enough water ran into the loose soil of the pit to completely fill it, with the result that in the morning the newly buried air-tight tank was entirely above the surface of the ground and washed as clean as though it had never been below.

Tanks are not always placed below ground; occasionally conditions render a situation above the surface desirable. Such a tank is shown in Fig. 3; this is situated near a large forge shop. Behind the tank is a tank car which is being discharged into the receiving tank. In the small brick pump house to the right of the tank is a motor-driven pump that keeps a constant pressure upon the oil system of the factory. The use of this form of tank adds another factor to the in-

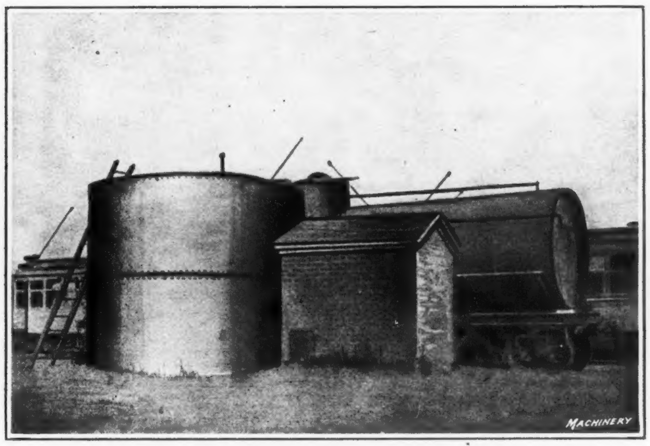


Fig. 3. Above-ground Storage Tank and Pump House

stallation. Since compressed air is necessary to discharge the car into the storage tank, an additional pipe line is required to carry the compressed air from the factory supply to the position where the car will be discharged, and time must be consumed in making one additional connection on each car.

The fullness of the description does not indicate a complicated or expensive system. Making all allowances for contingencies, the installation of a simple system, as described, and the piping (which is usually done by a shop's own crew) should not cost more than $250. If one cent a gallon is saved on the cost of buying the oil locally in small quantities, the saving on the first three or four cars of oil received will pay for the whole thing. Besides, it will save worry as to the non-delivery of the supplies needed daily in the shop.

Advantages of Oil-burning Casehardening Furnaces

Few factory managers realize that for actual heat value received for a given investment there is really little difference between the cost of fuel oil and that of high-grade coal or coke. There is too much tendency to look at a price of from two to four cents per gallon, and count the pennies seen there. A gallon of oil at an average density of 0.9 will contain approximately 7½ pounds of a fuel that runs, in heat value, close to 20,000 B.T.U. per pound; this will be equal to the heat given by an ordinary scoopful of coal, which will not run over fifteen pounds.

A year ago a large northwestern manufacturer was running his casehardening furnaces with hard coal as a fuel. Although he had the advantage of lake and rail freight rates on his carload purchases, the coal cost him $6.50 a ton on his siding, before he expended any labor unloading it. Fuel oil could be obtained from the Kansas fields at four cents a gallon delivered. In addition to one hour's labor each day for filling the casehardening pots, it took from four to six hours to tend the fire, wheel in coal, and remove the ashes, at a wage of 22½ cents an hour. The manager thought that oil at four cents a gallon was too expensive a fuel, but these figures convinced him:

Hard coal: Price, $6.50 a ton of 2000 pounds; heat value, 12,500 B.T.U. per pound; 38,460 B.T.U. received for one cent.

Fuel oil: Price, 4 cents a gallon of 7.49 pounds; heat value, 19,000 B.T.U. per pound; 35,570 B.T.U. received for one cent.

The heat value received in coal is 7.5 per cent more than that received from the oil. The hard coal required per heat is 400 pounds, which costs $1.30. The oil required for the same heat value is 34.9 gallons, which costs $1.39. The blacksmith's helper from a nearby forge adjusted the oil flame as it was necessary, so for an additional fuel expense of nine cents a day it was possible to save from 90 cents to $1.35 a day in labor expense. The oil consumed by that furnace was never actually measured, but knowing the high burning efficiency of the oil flame and the very poor and wasteful conditions of that old hard-coal furnace, the writer feels safe in stating that the furnace, when burning oil, operated on a B.T.U. input of about 50 per cent of what was necessary with the coal; so there must have been another saving in the fuel bill. There was another very satisfactory result of the oil-heated annealing furnace. The period each day of the anneal was approximately nine hours. As the oil flame brought the casehardening pots up to the correct soaking temperature much more rapidly than did the coal-fired furnace, usually doing so in less than two hours, as compared with five or six for the coal furnace, the penetration of the case was more than double the depth formerly obtained; a most desirable advantage.

This same manufacturer originally purchased his fuel oil in small lots locally and had installed a four-barrel tank, which, after each filling, was closed and the oil forced to the burners by compressed air. The success of each oil furnace led him to install additions, but finally he put in a large storage tank and a pumping outfit to keep a constant pressure on his pipe lines, abandoning entirely the original lay-out as inefficient.

Gravity Feed Systems

The ordinary types of oil feed lines for furnace equipments can be divided into the following general classes: gravity feed, pressure feed, and continuous-pumping feed. The first class, the gravity feed line, is the simplest installation, but it is applicable only for the very smallest installations, and cannot be used for larger ones without considerable variation from the lay-out shown in Fig. 4; it can be adopted by almost any small plant at little expense if the appropriation for that purpose is limited.

As shown, a 10,000-gallon storage tank is buried in the ground outside the building line. If the oil is to be bought in small quantities, the size of the storage tank can be reduced. Through a suction line extending to the bottom of the tank, the oil is drawn by a hand-operated suction pump. Any ordinary force pump is suitable for this purpose provided it has sufficient strength to force the oil against a head of about twelve pounds pressure; such a pump will range in price from $8 to $12. The pump forces the oil through a filter into a temporary storage tank somewhere near the roof. The filter is a fine-mesh screen, and is a most necessary adjunct to the system, especially where the oil is of low grade and full of dirt or small hard particles of tar, which would be likely to clog the small openings of the burners. The filter is readily cleaned of all the sediment that may collect by separating the pipe at the union and then separating the two halves of the filter.

The fifteen-gallon reservoir will contain enough oil to operate any ordinary two-burner furnace for at least half a day, and a few minutes work at the pump before starting the fires after the noon hour will fill the tank for the afternoon's run. A thirty- or a fifty-gallon tank can be used, but should the fuel consumption exceed these amounts, one of the more extensive systems would be more satisfactory. The pipe line extends from the bottom of the tank to the furnaces, but it is arranged in such a way that there is a return connection through a valve which will drain all the oil, both in the tank and in the pipe system, back into the main outside storage tank. This is a requirement of the fire underwriters' inspection service, in order that the oil in the tank may be drained out of the building each night to reduce the fire risk. The small pet-cock at the top of the tank is usually left open to exhaust the air from the tank, when it is being filled, and to admit air to prevent back pressure when the oil is draining away into the lines during the day. Should the pump have good suction power, the foot-valve at the bottom of the pipe in the tank is unnecessary and can be replaced by a ⅛-inch mesh strainer to prevent the admission of any large particles to the valves of the pump. Although the writer has seen only one of these systems, and that was in a single brass melting furnace in a small foundry, there are a number of them scattered around the country, and many have been successfully used.

Pressure Feed Systems

The general features of the pressure feed system shown in Fig. 5 are somewhat similar to those of the system just described. Yet it differs in the capacity of the plant, in the adoption of power for pumping, and in the use of air pressure

to provide a constant pressure upon the oil in the system. The capacity of this plant is very much greater than the first, and it may be increased to any extent by keeping the pump operating a certain length of time each day, while the oil is flowing out of the tank, to replace that consumed. This condition is also true of the gravity system, for if a laborer is kept pumping long enough each day, he can keep even a fifteen-gallon tank of fuel ready to meet any reasonable demands.

In the pressure feed system it is only necessary to have a pump of sufficient strength to charge the tank against the air pressure on it. It can be any old boiler-feed pump, which may often be bought second-hand, because, even though it is no longer sufficiently reliable or powerful for boiler service, it will be able to force thick oil without leaking over too much in the drip pan. The pump shown in Fig. 7 was recovered from some old steamboat scrap, yet it is giving most effective service in its new job.

One objection to oil as fuel that has been cited by many who have had little experience in its control is a "popping" or "puffing" flame that may be encountered, which seems to be due to the oil not flowing steadily. The cause of this trouble may almost invariably be traced back to an unsatisfactory condition of the pumping outfit which in some way introduces water or, more often, air into the oil stream; consequently when these air or water bubbles reach the burner they temporarily shut off the flame. As the air passes through an opening much more rapidly than the oil, the velocity of flow of the oil is momentarily increased in the pipe so that a heavy spurt of oil is forced into the furnace, giving a large puff of flame. This is an annoying condition, as it gives an unsteady flame and produces an unnecessary amount of smoke in the shop. This trouble can always be remedied by insuring a perfectly air-tight pipe line on the suction side of the pump, as it is through leaky fittings that the air usually enters. A tight packing about the rod of the piston of a double-acting pump will insure the non-admission of air at this point. This trouble is felt more when the pump discharges directly into the main pipe line to the furnaces. Where the oil first enters a temporary storage tank, as in Fig. 5, a pet-cock placed at the top of the tank permits the escape of any air that accumulates there; it also acts as a guide to indicate when the tank is full.

Some of the lower grades of oil from the western fields contain considerable water, and occasionally this is augmented by the seepage of condensed steam from a leaking steam coil in the tank car. This water always separates from the oil after a short time and settles to the bottom of the tank; naturally the suction line of any pump drawing from the bottom of the tank will pick up a large part of this water. In the system shown in Fig. 5, the water settles to the bottom of the reservoir soon after filling; if very much is allowed to accumulate there, it will reach the level of the feed line and flow out in it, causing trouble at the burners. To prevent this happening, a pet-cock should be placed at the bottom of the tank so that all accumulations can be occasionally drained off.

The oil filter is on the delivery line from the pump to the reservoir, so that it may be cleaned any time during the day without interfering with the flow of the fuel to the furnaces. Another safety device in this system is the "automatic safety cut-off for excess flow." This acts to stop the flow in case a fuel pipe line should break. If there were no such provision, the oil might flood the neighborhood of a furnace and ignite, causing considerable damage. When such an accident occurs there is a sudden rush of oil, greatly in excess of normal, through the new opening. As soon as the reduction in pressure is felt by the delicately balanced plunger in the automatic cut-off, a trip on a spring-operated valve is worked, and almost as soon as the accident has happened all pressure has been cut off from the oil, the leakage stopped, and the danger has passed.

As is shown in Fig. 5, the pressure necessary to cause the oil to flow through the system is obtained by admitting compressed air. However, most air systems are operated at a pressure of about 100 pounds, which is too high for the most successful burning of the fuel. Consequently an air-pressure reducing valve is introduced in the air pipe line and a pressure of twenty-five pounds is maintained on the tank. As reducing valves sometimes get out of order, a safety pop-valve can be placed on the top of the tank.

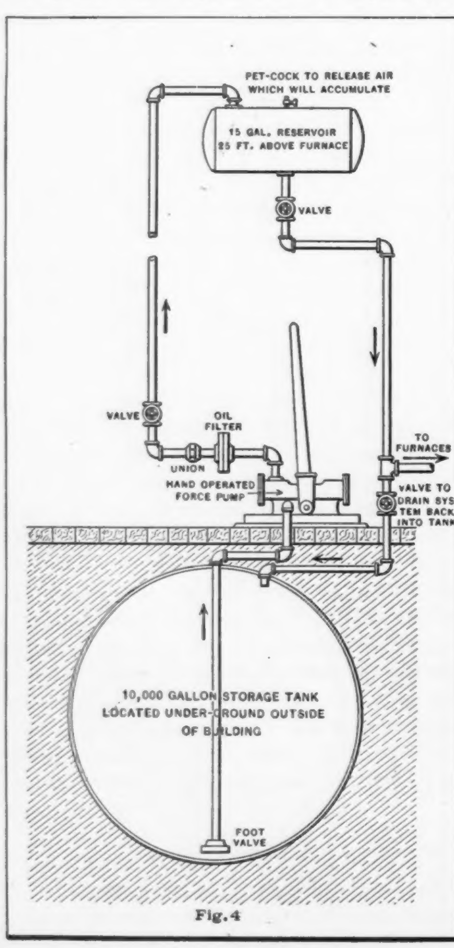


Fig. 4. Oil Gravity Feed System

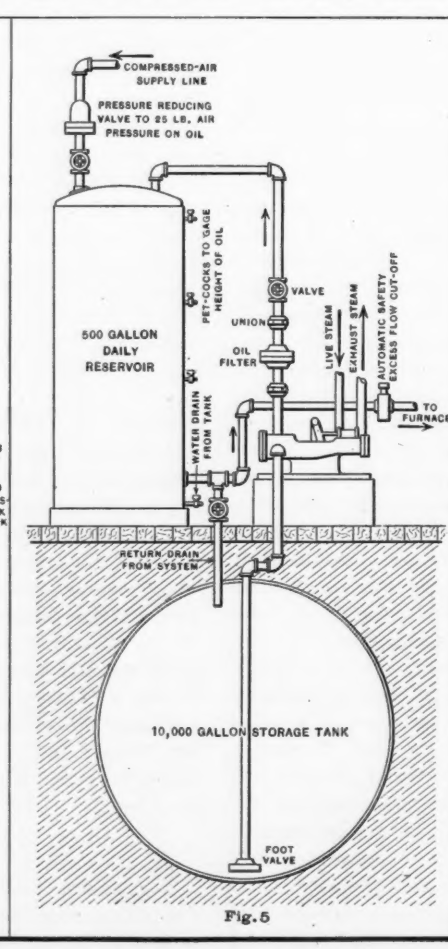


Fig. 5. Oil Pressure Feed System

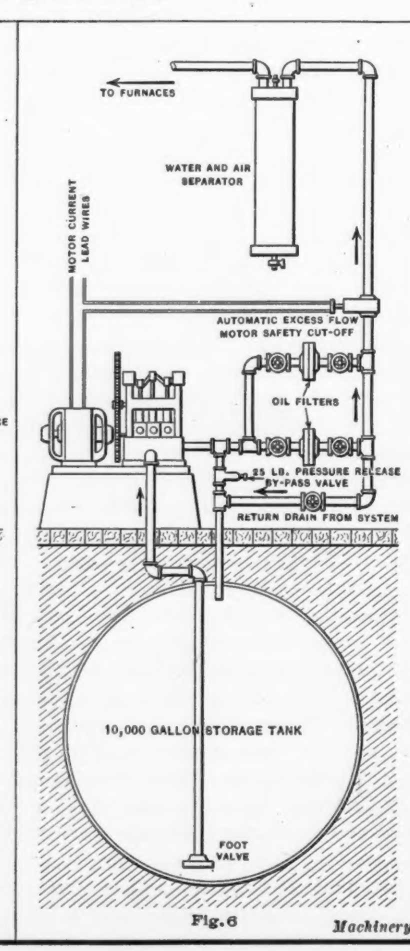


Fig. 6. Oil Continuous-pumping Feed System

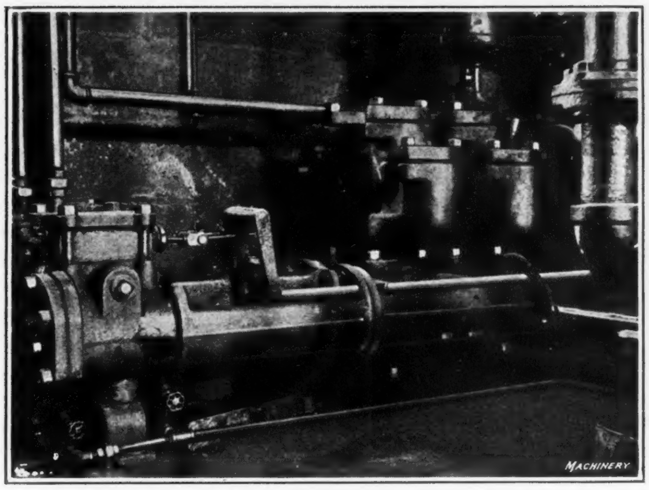


Fig. 7. Old Steamboat Pump used in Pressure Feed System

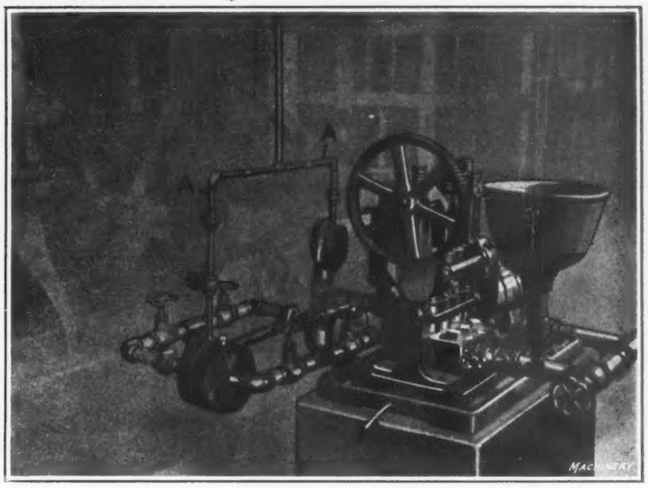


Fig. 8. Pump for Continuous System; also Filter Arrangement

A large electric railway repair shop that occasionally runs a night crew has installed a standard electrically driven compressor for air-brake service on a separate air line close to the tank. As the oil furnaces use only low-pressure fan-blown air for combustion, it is undesirable to run the large air compressor to provide air for the oil-storage tank. So, at night, the regular air-supply line is shut off to avoid filling the whole system, and the little compressor is cut into service. All electric compressors of this type are provided with an automatic cut-out that stops or starts them when the pressure rises or falls within certain prescribed limits. This automatic switch has been set for limits between twenty and thirty pounds pressure, and with very little effort holds the pressure between these points. This air compressor and the automatic switch mounted on the wall above it are shown in Fig. 9.

Continuous-pumping Feed Systems

The most recent development in the oil-supply system is the use of a continuously operating pump, which furnishes a constant supply of fuel to the system and by-passes the unused part to the storage tank. This system involves no large reservoir with its supply under pressure, in a position constituting a fire hazard, and may be considered safer on that account. The system is shown in outline in Fig. 6, and a pump, with its filters, is shown in Fig. 8.

The pump shown in Figs. 6 and 8 is a small direct motor-driven pump of three cylinders, but a steam-driven pump may be used. A steam-driven unit will be more expensive to maintain, but many plants use it because they have a small boiler feed pump that can be adapted for the purpose. No ordinary plant will need a pump of greater capacity than 120 gallons an hour; this will be large for most places, but a smaller pump will cost no less nor take appreciably less power. The power consumption of a motor to drive this size pump is remarkably small; the motors range in size from one-fourth to one-half horsepower. A complete motor-driven pump can be obtained for about $125. A gear-driven outfit is especially desirable; a pump driven by a belt is not as reliable, because the oil will inevitably get smeared about and cause the belt to slip.

On the delivery line from the pump is located a pressure-release by-pass valve which is set for the pressure at which it is desired to operate the system. This valve opens to a line that returns direct to the main storage tank. Some pipe-men, when installing the equipment, object to running the long extra return line to the tank and want to send all the by-passed oil back into the suction line. This arrangement, however, is very objectionable because the pump will always draw in a little air, and if the furnaces are using little oil, the greater part of this air will be by-passed back into the suction line. As a result, the air will accumulate in the pipe line, and much more will pass into the line to the burners than would otherwise, giving an unnecessary amount of trouble with "puffing" flames.

One duplication in the continuous feed system that is unnecessary in the previous types is the double oil filter. In the other systems the oil filters can be cleaned any time after the tank has been filled, but with the continuous feed system the filter is in continuous operation. To avoid any possibility of a temporary shut-down should the filter become clogged when cleaning very dirty oil, a duplicate filter is provided, which is cheaply arranged. Then if one ceases to work, it is merely necessary to open the other, and close the valves to the first one, which may be cleaned at the attendant's convenience.

The automatic excess-flow safety cut-off for this system serves the same purpose as the one already described. The only difference is that this valve is connected with an electric switch installed in one of the leads to the motor. In case of accident, this automatic switch immediately disconnects the motor line and stops all pumping of oil. To separate any air and water that may pass into the line, a separator can be cheaply constructed of pipe fittings. This will afford a small chamber of slow flow in which the water can settle out of the oil and the air can rise to the top to be released when necessary.

The writer can recall but one serious shut-down in installations of this type. The tank was situated about fifty feet from the building, underground and close to the railroad track. When a large shipment of bar iron was unloaded, about ten tons were piled across two logs in this intervening space. One of these logs ran squarely across the suction pipe line, which was only two feet underground. Then when the dirt was softened by rain the log settled under the load until most of the weight was placed on the pipe, which naturally pulled apart at the nearest elbow. As soon as the trouble was located, a temporary connection was made above ground to the tank, which furnished oil until repairs could be made.

Necessity of Filters in Feed Lines

Many machine tools and systems established in manufacturing plants have failed to be of the greatest possible value to the owners because the men in direct charge of them have not understood them sufficiently to develop them to the utmost efficiency. The adoption of oil for the heating of work in forge-shop practice has suffered through neglect and misunderstanding of its advantages in the same manner. In some shops, oil heating has never been carried beyond the preliminary stages because some irregularity in its operation has caused it to be considered unreliable, when the real cause of the irregularity was either faulty installation or ignorant or inexperienced handling.

One western gas-engine manufacturer, who found it necessary to install an oil furnace for casehardening, built a furnace that a so-called expert told him was admirably suited to his class of work. The interior arrangement of the furnace was all that was to be desired, but it took all of one man's time to keep the oil adjusted and the burners clean. The reason for this was that the only oil available contained particles of asphalt, or other gummy substances, which clogged the small oil openings in the burners. No one had ever explained to him that installing a fine-mesh wire strainer in

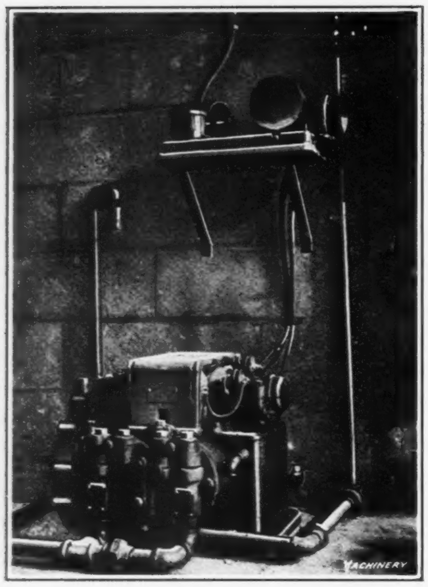


Fig. 9. Electric Air Compressor with Automatic Switch

the pipe lines would quickly remedy this difficulty. Hence, it was years before he could be convinced of the desirability of using oil-heating in some of the other processes in his shop.

The difficulty with clogged burners could have been remedied by the introduction of a filter in the first part of the pipe line from the pump or storage tank, and preferably close to it. A fine-wire mesh filter admirably suited to this purpose is shown at *A*, Fig. 10. It consists of two gray iron castings, machined on only one surface so that they may be bolted together to provide a non-leaking joint, with a pipe inlet or outlet tapped into each side for the oil flow. Another pair of pipe connections is provided when it is desired to clean the filter by passing steam through it instead of taking the filter apart. This steam connection is shown at *A*, Fig. 8. A screen of 1/32-inch mesh brass wire is loosely clamped between the two sides. This, in turn, is supported by a 1/4-inch steel plate punched fairly full of 1/2-inch holes. The object of this plate is to take up the pressure over the entire area and support the screen should the latter become so clogged that, failing to pass any oil, the full pressure would fall upon it.

In a simple installation, without the steam-cleaning connections, the filter is removed when clogged, and the sediment is blown off with compressed air or the screen is washed in kerosene. In the first installation in which the writer used steam for cleaning, the steam pipes for heating the tank passed so near to the filter that it was no trick at all to try the experiment. This plan worked exceedingly well, because the heat thus applied softened the gummy sediment so that it was quickly blown off and passed through the waste pipe.

Air and Water Separators

Another difficulty in the operation of oil burners, as has been mentioned, is due to the introduction of small quantities of water or air into the pipe lines. These cause the oil to burn poorly and unsteadily with a smoky, puffing flame that will not heat properly. This trouble can be overcome by the apparatus shown at *B*, Fig. 10. This is made of two caps and one piece of six- or eight-inch pipe, the larger the better. The oil passing in through the pipe at the left, which extends well into the reservoir, forces the oil to rise slowly at a decreased velocity through the larger pipe. This gives any water that the oil may contain ample opportunity to separate and settle to the bottom of the container. At the same time, the little bubbles of air will rise to the top of the container, where space is provided above the end of the outlet pipe to the oil line. Both the air and the water that have been entrapped can be removed at regular intervals through the drain cocks provided at the top and the bottom of the so-called trap.

Efficient Oil-burning Pressures

Opinions among oil-system experts vary greatly regarding the proper pressure for the most efficient burning of this fuel; that is, the pressure which should be carried on the pipe lines to the burners. The range is from five to twenty-five pounds; very few, however, go below ten pounds, while occasionally some go as high as fifty. These high pressures are used when a line has been overloaded and it is necessary to increase the pressure in order to increase the flow. A range of working pressures between twenty and twenty-five pounds can be recommended as the best adapted for all conditions. These pressures give the best burner-nozzle spray and at the same time keep the pressure low enough, from a safety standpoint. With low pressures, the burner-nozzle adjustment must be kept more widely open to admit sufficient oil; and at the same time there is likely to be a thick, sluggish stream of oil that will not break up readily in the air blast, and consequently will give a smoky, inefficient flame. Low pressures also decrease the volume of oil that will flow through a given size of pipe and thus necessitate the installation of larger sizes. From the standpoint of economy, factory owners demand the cheapest installation and the most efficient fuel-burning system. Large sizes of pipe lines will not decrease the cost of installation; yet when using heavy grades of liquid fuel it is necessary to provide much larger lines than would be necessary for an equal flow of water, because the oil flows so sluggishly through the pipes in cold weather. Table 2 gives an approximate idea of the sizes of piping that can be recommended for varying consumptions of oil; it is based on the number of burners that draw their supply from a line.

When one considers that the approximate consumption of an ordinary burner will not exceed four gallons an hour, it may seem excessive to install such large pipe for so small a service, but in the winter the consistency of crude oil may become that of stiff vaseline, so that considerable space will be required for the oil to flow in if any is to be delivered to the burners. In one system containing three burners, a one-inch pipe was laid about 600 feet out of doors, two feet underground, in a line to supply the foundry, and a great part of the way it followed close to the steam-heating mains. But on very cold days it was necessary to raise the pressure at the pump to sixty pounds in order to deliver sufficient fuel to the burners.

Some sort of valve or cock should be provided at the end of the run-offs of the pipe lines to the different departments, so that each can be shut off without interfering or disarranging the service to other departments. Some of the mutual insurance companies also require that a valve be placed on all fuel-oil lines just at the point where they enter a building, so that, in case of accident, the supply of oil can be shut off.

Types of Oil Burners

If all the kinds of burners that have been made for fuel oil were listed, it is probable that their number would run well into the thousands. The writer does not think he has visited two plants that used identically the same oil burner in the same manner. Each man seems to have changed the burner in some way, and each is sure that his type is really the one that should be adopted for all work. Moreover, nearly every description of an oil furnace that appears in the technical press includes a description of an improved oil burner, thus adding its quota to the previous designs. Recently, an acquaintance spoke of some investigations he had conducted to obtain the most suitable oil burner for glass-factory work, and said that he had obtained sample burners from all over the country which he had tried. Yet he did not select any of these for his purpose. He designed one that he thinks, for just this service, is better than any other. Therefore one must hesitate to give a description of the different types of oil burners that will be satisfactory for factory use; for what someone else thinks is the one "best" type may be entirely overlooked. However, the number of models that will suffice for most purposes is less than ten; and the only reason for

TABLE 2. SIZES OF PIPES FOR OIL DISTRIBUTING SYSTEMS

Approximate Rate of Consumption, Number of Burners	Pipe Sizes in Inches, for Varying Distances to Point of Consumption			
	100 feet	200 feet	400 feet	800 feet
1	½	¾	1	1
2	¾	1	1	1¼
4	1	1¼	1½	1½
6	1¼	1½	1½	2
8	1½	1½	2	2

Machinery

more than two or three is that there are several systems of supplying the air for the spraying and burning of the oil, and each of these requires a different type of burner.

To burn fuel oil completely in a furnace without giving off a heavy and offensive smoke, it is necessary for the oil to enter the furnace in a fine spray, and be surrounded at its entrance point with the air necessary for its complete combustion. At the place where this spraying is accomplished is the device known as the burner. Owing to the viscosity of fuel oil, it cannot be projected through any known nozzle by its own pressure and turned into a spray like water emerging from the common lawn sprinkler. Consequently, some agent must assist the spraying action. Ordinarily, this is done by the air, under greater or less pressure, that is provided for the combustion of the oil, although high-pressure steam has been used for this purpose, the air for combustion being furnished in some other manner.

Almost everyone is familiar with the manner in which ordinary illuminating gas, issuing from the end of a plain pipe, will burn with a low-temperature smoky flame; and how the application of the Bunsen, or blast of air, principle will produce with the same amount of gas, a fierce flame of much higher temperature. This same principle applies to the burning of fuel oil, for oil burning without auxiliary aid seems to produce little heat and much smoke. The air for this combustion may be supplied by one of three methods, namely: "low pressure," in which the pressure ranges from four to fourteen ounces; "high pressure," with a range of from ten to eighty pounds; and a combination of the two, in which high pressure air is supplied, in small quantities, immediately to the jet of oil to insure a more complete degree of atomization of the spray.

Of these methods, the first is the most economical for the first cost of installation, because a blower fan can be bought and installed for a fraction of the cost of a high-pressure compressor outfit. Those that claim they have the compressed air already installed in their plant must remember that, with an expanding business, the time will come when all the high-pressure air will be required for other purposes that cannot be filled by blower-driven air. Moreover, the cost of compressing air to sixty or eighty pounds is in direct proportion to the cost of blowing it at one pound; and while a little more of the latter is required to obtain the same efficient degree of combustion, the power consumption will be much less.

So far as the efficiency of the oil burning is concerned, either of the other methods is better as a general rule. This is due generally to a better atomizing of the oil, which tends to produce more complete combustion at a higher temperature. While this is the general rule, it does not by any means appear to apply to all cases, for when a good low-pressure system is correctly installed and carefully maintained (so that the oil nozzles do not become burned out or clogged with heavy, oily dirt) it seems possible to obtain quite as efficient combustion of the oil from this system.

When buying or installing a blower for use in a low-pressure system the first essential is that the blower will deliver air at sufficient pressure to keep all the burners supplied at the right pressure. Too many blowers are run at so low a speed that the air gives little assistance toward spraying the oil, so from one day's end to the next the owner spends his time condemning the inefficiency of his oil burners, while nine times out of ten it is a condition due solely to too low air pressure. Positive-pressure blowers are more reliable to meet this condition, since they deliver a constant volume for each rotation of the impellers, and if they have been speeded fast enough to have their safety valve just on the verge of blowing off under full load, they can be relied upon to deliver their air under almost constant-pressure conditions. But these positive blowers are very noisy, and only a foreman who has attempted to make his orders understood by the workmen in a shop where one of them is running will know how difficult this is when the blower is running constantly. Consequently, if this type of blower is to be used, and, as explained, it is in some ways more desirable, it should be installed in some outbuilding away from the shop; or if it must be in the shop, it should be enclosed by a sound-proof hollow-tile wall.

Blower fans are sometimes built with special housings that are much larger than the standard sizes. These, when run at a lower speed of rotation, will still have a high centrifugal speed at the outer circumference of the fan blades and, consequently, at these speeds will deliver the air at as high a blast pressure as that obtained from much higher speeds using the standard types of blower fans. However, there is little to be gained by buying these special fans. The buyer should be careful to consult the manufacturer of the blower fan that he is getting and ascertain the speed at which it must be run in order to insure the delivery of air at not less than ten ounces of pressure, for the average lead that he expects to carry. In fixing the pressure at ten ounces, the writer does so knowing that oil burners will give excellent service at this pressure; and will even do good work, on the average, at pressures below this point. However, there will always be drains on the air system that were not foreseen, so it will probably be seldom that the fan will deliver any more than is actually needed from it. When a blower is to be driven by an individual motor, the direct-connected type should always be chosen, for then the many troubles of belts run at the high speeds of fans will easily be avoided.

It is hard to estimate the amount of blower air that will be required by each burner, since there is always some loss from the amount theoretically required, but it has been determined that 306 cubic feet of free air is required to burn one pound of crude petroleum. It is better, though, to allow at least 350 cubic feet of air for each pound of oil that will be burned. So that estimating the average large size burner to have a consumption of forty-five pounds (approximately six gallons) of oil an hour, the blower should deliver approximately 15,750 cubic feet of air an hour for each burner that will be in use.

For conveying the blower air to the individual burners, pipes smaller than three inches may be used, but it is inadvisable to do so. Experience has shown that small pipes restrict the delivery of the necessary amounts of air and reduce the pressure, if due to the friction developing in the pipes. The main pipe at the blower should be the same diameter as the blower outlet and may be decreased in proportion to the number of side outlets that are taken off as it progresses through the shop. For pressures up to several pounds, pipe of standard galvanized sheet steel, about No. 20 gage, has ample strength. The joints of this pipe should be soldered to insure against extensive leakage.

A control valve should precede each burner on its individual air supply line, so that the amount of air entering the burner may be adjusted to the amount of oil being burned and the size of flame. These valves are very simple; two small flanged iron castings are bolted together with a small space between in which a 1/8-inch plate can slide to act as a gate.

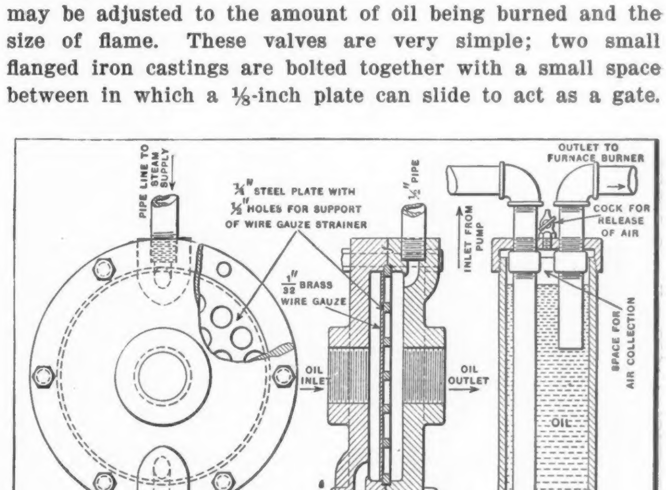


Fig. 10. (A) Filter. (B) Air and Water Separator

High-pressure air burners also require valves, which should be placed close to the oil-control valve, so that in starting the fire it will be possible to control one with either hand until the correct adjustment is obtained.

In Fig. 11 is shown the simplest type of low-pressure oil burner; it is one that has been used by nearly everyone that has built his own furnaces and by some furnace manufacturers as well. Its simplicity of adjustment and the ease with which it may be cleaned are its most desirable points. The air casing is a simple goose-neck casting, within which a 1/4-inch pipe is centrally placed. This pipe, which extends almost to the outlet, passes through a small side outlet in the casting. This is tapped for a small clamping set-screw for the adjustment of the oil outlet, since for some conditions it must be advanced or withdrawn. The pipe tee on the outside end of the oil-pipe nozzle is one of the most important features, since after the flame is shut off the heat of the furnace often causes the heavy oil to congeal and close the oil outlet. Consequently, when it is impossible to get any oil in the furnace in the morning, it is simply necessary to close the oil valve, remove the plug, and run a small cleaning rod through the nozzle.

A variation of this type of burner has a small steel cone that slips freely over the oil nozzle and is tapered so that it will fit the taper of the inside of the air nozzle. By means of a small rod that extends out through the air casing, this sufficient air through the inside nozzle at all times, a small butterfly valve is placed in the outside air pipe, as shown in dotted lines at X. By adequately adjusting this the necessary amount of air can be forced to flow through the inner air pipe.

After the burners that utilize low-pressure air exclusively comes the class that employs a combination of both high- and low-pressure air. A typical burner of this class is shown in Fig. 13. High-pressure air gives much better results in the atomizing of oil than can be obtained with low-pressure air. This is due possibly to the fact that the former, in escaping from the nozzle, expands at a very rapid rate, and when doing so the currents of air carry the oil spray outward with them. As will be noted, the oil in this burner is fed through a small centrally located pipe that has a slightly pointed nozzle. A needle-valve adjustment is provided at this point for further regulation of the oil supply, which for safety and to prevent any oil leakage when the burner is not in operation must be provided with another oil-control valve back farther from the burner. Another purpose of the needle valve in the burner nozzle is that it may be conveniently withdrawn for cleaning in case the burner clogs.

The high-pressure air is fed through a slightly larger pipe surrounding the oil pipe, and likewise terminates in a pointed nozzle, which extends approximately an eighth of an inch in advance of the oil pipe. This air pipe need have but little clearance over the oil pipe, for the amount of high-pressure

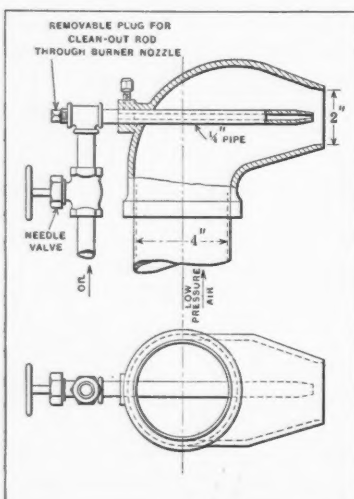


Fig. 11. Simplest Type of Low-pressure Oil Burner

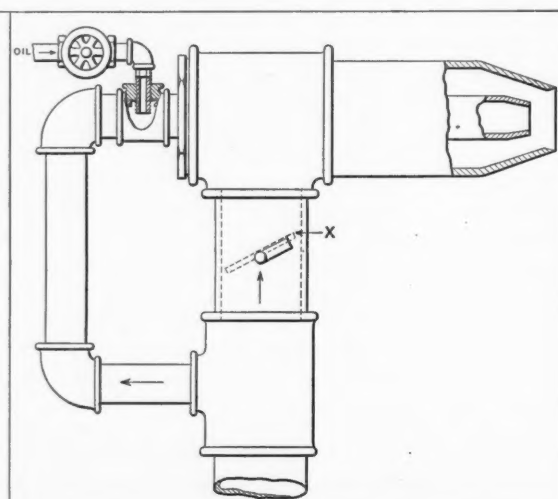


Fig. 12. Low-pressure Oil Burner made of Standard Pipe Fittings

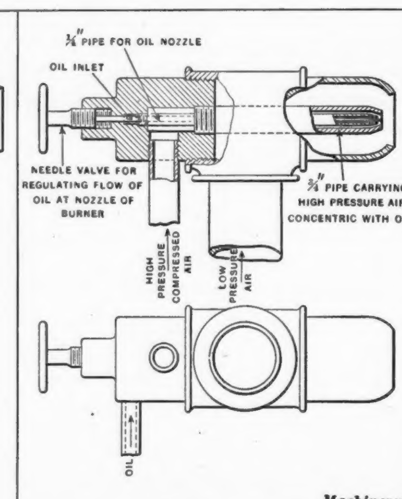


Fig. 13. Combination High-pressure and Low-pressure Burner

cone can be pushed forward or withdrawn. In this way, it regulates the amount of air flowing at the nozzle and makes possible a desirable adjustment for a long or short flame.

Another form of burner for low-pressure air is shown in Fig. 12; this can be made entirely from standard pipe fittings. This burner was designed by a foreman in a large railway forge shop, and was used extensively for this class of furnace work. As will be noted, part of the air blast is by-passed through a side pipe loop, which returns through the center of the main blast. The oil is fed into this side air pipe some little way back from the outlet. It was thought that the air would spray the oil as it came out of its feed pipe and would carry this spray to the point where it met the main blast, which would further aid in forming a mist of the oil. But experience with high-pressure burners of somewhat similar principle has shown that it is more probable that the first blast drives the oil, in an even skin coat, along the inside surface of this pipe to the nozzle, where it sprays off in a minutely thin layer from the entire circumference and is caught at this point and atomized by the second blast of air. Consequently, if this nozzle were not close to the larger outlet, it would again drive the oil into another thin skin coat on the inside of the larger pipe. But if the burner is well designed and the inside nozzle is close to the outlet of the larger, there should be no reason for not obtaining a finely subdivided spray. This burner needs very careful regulating for all changes in the degrees of heat required. In order to force

air that is required will be small in comparison with the amount of low-pressure air required for combustion. The low-pressure air conveyed in the large pipe surrounds the other two, and may extend from a quarter to a half inch in advance, depending on the size of the burner. Both air lines must be controlled by suitable valves, so that the air supply may be regulated when starting the fire or when altering the size of the flame. When starting this type of burner, that is, when firing up a cold furnace, less trouble will be experienced if the oil and the low-pressure air are turned on first; then as soon as a flame is obtained the high-pressure air may be turned on very slowly. By this method a fire may be started readily, whereas if the high-pressure air is on at the beginning trouble will be experienced by the flame blowing out and giving forth the dense white fumes of unconsumed oil.

In Fig. 14 is shown one of the most satisfactory high-pressure air burners the writer has seen. It is particularly adapted for such furnaces as rivet heaters or tool dressers because of its short, intensely hot flame. But it is just as useful when in such service as ladle heaters in the foundry and in service that presents no permanent incandescent wall for the ignition of the oil vapor, because the oil is atomized to such a fine mist that it ignites itself almost as readily as a gas flame would do. This is a small and particularly compact burner, for as usually made it measures about four inches in length. The oil- and air-pipe nozzles enter at one end of the thin outer cylindrical shell. The oil nozzle extends a short

distance in front of the air nozzle and is turned upward in such a way that the air, in leaving its nozzle, sweeps across the end of the oil nozzle and picks up the fuel in its blast. From this point it would appear that the action of the interior of the burner is somewhat similar to the action described in the burner shown in Fig. 12; that is, that the oil drives for-

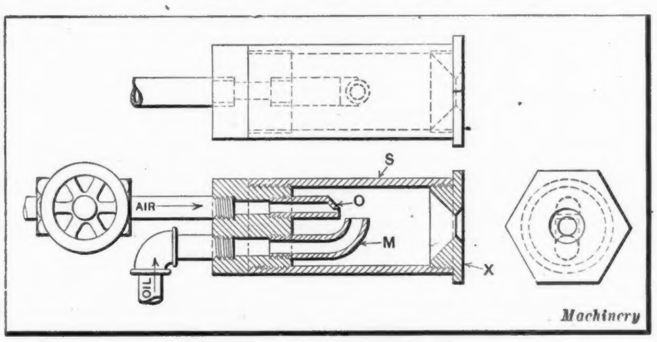


Fig. 14. High-pressure Burner

ward in a thin sheet along the inside wall, converging toward the sharp edge of the outside nozzle, and from this point mists away in a finely atomized condition.

The oil nozzle should never be designed to put the oil in a thin sheet to be picked up by the air blast; it will not work. It might be thought, judging from the needle valve outlet of the burner shown in Fig. 13, that by extending this principle in some way, such as prolonging the needle, a thin sheet of oil could be obtained that would be more readily sprayed by the blast of air. This might be possible with water, or even with gasoline if it were clean or could be fed with sufficient force to keep the opening clean, but oil carries so many thick particles that small burner openings will be clogged in almost an instant, and burners designed on this principle have proved failures.

* * *

WHEEL DRESSING AND TRUING

BY HOWARD W. DUNBAR [1]

Frequently, one hears grinding-machine operators refer to the use of a diamond, or a wheel dresser, on a wheel as a truing operation; at other times, this is referred to as a dressing operation. There appears to be some confusion in the minds of operators as to the distinction between these operations; therefore, an effort will be made here to make the meanings of these terms clear.

Dressing a Wheel

The wheel face is dressed after it has been worked to a point where it no longer acts as it should; that is, the wheel may have become loaded, the particles dulled, or the face of the wheel smoothed up so that it does not cut freely. A dressing operation frees the worn-out and useless grains in the face of the wheel and presents new particles of abrasive in the grinding operation, making what the operator calls a "sharp" wheel. Sometimes this is called "roughing up" the wheel, and is usually done only when rough-grinding, as such a condition in the wheel face cuts off material very rapidly. The wheel does not of necessity have a perfect face; it may be slightly out of round, it may not be exactly parallel, or it may not be exactly concentric, but for rough-grinding, when removing a lot of material, it serves its purpose.

After considerable investigation, the Norton Grinding Co. has found a means for accomplishing this result without using a diamond, and is now recommending the "Huntington" dresser, which is especially designed for use with Norton grinding machines. This dresser is held in the diamond tool-holder in the same manner as the diamond, and is passed in front of the wheel for the purpose of dressing it. There are many reasons why a dresser is recommended for this purpose, but the principal one is the scarcity, expense and unreliability of diamonds at this time. It must not be understood, however, that diamonds cannot be used for dressing purposes, because they can be used and will produce the same results, but always at the expense of the diamond. On the other hand, dressers cannot be used for the fine finishing operation, which can only be done by using a diamond for correcting the wheel face. It is difficult to draw the line between the use of the dresser and the diamond, as it will depend on the results desired. As operators acquire more and more skill, the dresser, by careful use, will find a wider and wider field.

[1] Address: Norton Grinding Co., Worcester, Mass.

Truing a Wheel

Truing a wheel has for its object the correction of the wheel face and the perfecting of the wheel so that it will grind perfectly round and smooth work. This can be accomplished with satisfaction and economy only by the use of the diamond. When truing, the face of the wheel is made straight or parallel with the work to be ground. It is made concentric with its mounting, so that the extreme point of every particle in the face is exactly the same distance from the center of the wheel. The truing operation is also done for the purpose of producing the particular kind of face desired for the work in hand. The ability to do this is a part of the grinder's skill. It is something that is difficult to teach, but is an accomplishment that comes naturally to a skillful operator. A great many times in producing the desired result in ground work, it is necessary to dull the face of the wheel instead of sharpening it, which is contrary to the belief of the inexperienced.

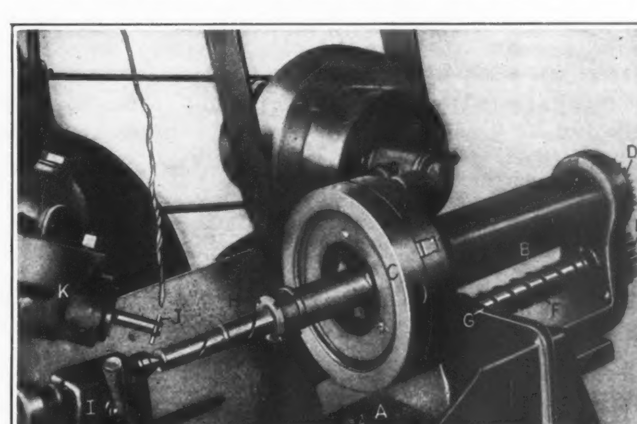
No ground work can be any more perfect than the wheel that produced it, so the importance of the diamond for truing is easily seen. The highly reflecting, bright surfaces sometimes noticed on ground work could not be produced without the diamond; 0.00025-inch limits would be unheard of in grinding, and flat or round work would be impossible except by tedious lapping operations.

* * *

MILLING OIL GROOVES

BY ROBERT MORRIS

The illustration shows how some special shafts were oil-grooved in a Whitney milling machine. The fixture *A* is provided with a large hollow spindle *B*, on the end of which is mounted a scroll chuck *C* taken from a Whitton centering machine. At the rear end of the spindle is a gear *D* which meshes with a gear *E* keyed to the lead-screw *F*, which engages a nut in the end of bracket *G*. Bracket *G* is secured to the knee of the milling machine. The work *H* is held in the chuck *C* and the outer end is supported by the tail-center *I*; it is also secured to the fixture *A*. As the table of the machine is fed to



Cutting Oil Grooves on Whitney Milling Machine

the left, it carries the fixture and the work with it, and the stationary nut in the bracket *G* forces the steep pitch lead-screw *F* to rotate. The rotary motion of the lead-screw is transmitted through the gears to the spindle and work. The grooving cutter *J* is mounted in and driven by the universal head *K*. The work done with this arrangement was entirely satisfactory.

* * *

The newly discovered beds of molybdenum ore in southern Peru are said to be the largest known molybdenum deposits in the world.

MAKING DIE-PRESSED CLUTCH CASTINGS

There are many small parts of machines and instruments, and numerous metal products that may be produced advantageously by a method known as die-pressed casting. A variety of metals can be worked in this way, although the most satisfactory results are obtained with brass and other alloys that can be made to flow without applying such high pressures that the dies are destroyed rapidly. In an article entitled "The Production of Die-pressed Castings," which was published in the January, 1916, number of MACHINERY, general information was given concerning the construction of the dies and methods used in work of this kind. It is the purpose of the present article to describe the design and method of making a set of dies for the production of the small brass clutch shown at *A* in Fig. 1. In this illustration are also shown pivot *B*, on which this clutch is assembled, die *C* and swaging punch *D*.

The assembled punch and die for making the clutches are shown in Fig. 3, in which one of the die-pressed clutches is shown in place at *A* in the closed die. It will be noticed that die *B* is supported by a cast-iron shoe. The brass blanks from which the clutches are pressed are turned up on a Brown & Sharpe automatic screw machine, the blanks being flat disks with a hole in the center of a diameter equal to that of a circle which could be circumscribed around the pentagonal shaped hole at the center of the clutch. Punch *C* has a flat face, and there is a hole in it just large enough to provide a sliding fit for pentagonal swaging punch *D*, which is pressed into the bottom of the cast-iron die-holder. In operation, the brass blank is dropped into the die and properly located by the pentagonal punch *D* that slips through the round central hole. When the press is tripped, the application of pressure by punch *C* causes the metal to flow down into the die cavity, which results in forming the clutch teeth; and, in addition, the metal flows inward around swaging punch *D*, so that the circular hole in the blank is changed to the required pentagonal shape. The metal also flows outward to fill out the hole in steel collar *E*, which provides for securing a nice finish on the edge of the work.

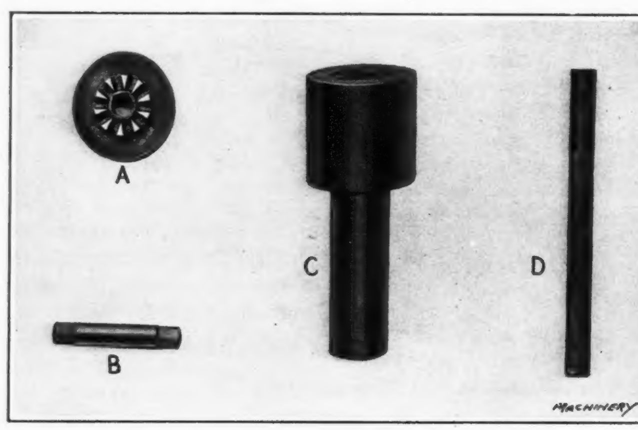


Fig. 1. Clutch A, Pivot B, Die C in which Clutch A is pressed, and Swaging Punch D for forming Pentagonal Hole

After the press has completed its downward stroke and the ram starts to rise, cross-bar *F* comes into contact with the bottom of die *B*, as shown. This result is obtained by having

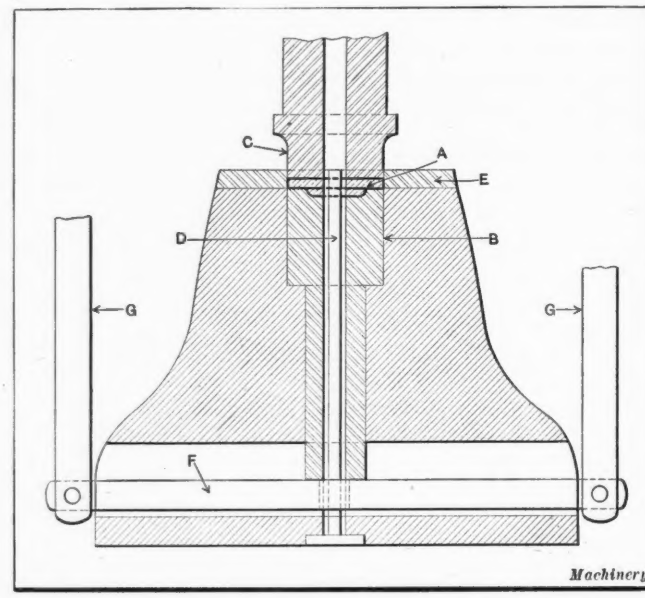


Fig. 3. Punch and Die used for making Die-pressed Clutch Casting shown at A

cross-bar *F* connected to vertical rods *G*, which are coupled to the ram of the press, and after the engagement of bar *F* with the die—which takes place when the ram is close to the top of its upward stroke—continued movement results in lifting die *B* a short distance out of the holder. This provides for stripping work *A* off swaging punch *D* and lifting the top of the die clear of the holder, so that the operator may reach in and pick the finished die-pressed casting off the top of the die. It will be apparent that the edge of the work is exposed so that the operator is enabled to get a good grip with his thumb and index finger; and as the sides of the die cavity are given a draft of about 0.001 inch, no difficulty is experienced in removing the work. It may appear that this method of picking the pieces off the die by hand would make the cost of production exceedingly high, but on this particular class of work the output obtained with this die equipment is said to be far in excess of what would be obtained in producing the parts by any other method. Attention is called to the fact that a hole is drilled through cross-bar *F* to provide clearance for swaging punch *D*.

In starting to make this die, the first step was to take a piece of Ketos steel and turn a blank, Fig. 2, to a diameter *D* plus the necessary allowance for finish; after this had been done, the stem of the die was turned down to a diameter *d*. For sinking the impression in the die, a male force was made with projections corresponding to the clutch teeth, and these were tapered 0.001 inch on the sides to provide sufficient draft for the die-pressed castings to be easily removed. In addition, this force was provided with a pilot for countersinking an impression at the center of the die. The next step was to make a cast-iron die-

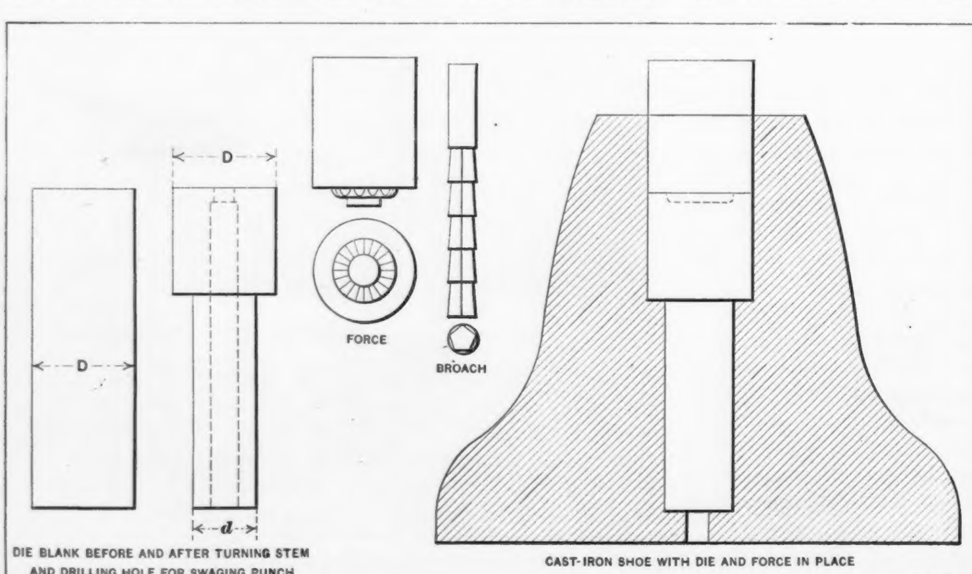


Fig. 2. Die Blank, Force for making Die Cavity, Broach for Pentagonal Hole in Die, and Holder in which Die Cavity is formed by Force

holder suitable for supporting the die blank in a vertical position, the hole being deep enough to allow the force to be dropped in on top of the die blank in the manner shown. The die blank was heated to a cherry red and immediately placed in the holder, which had already been set up under a drop-hammer; and being careful to avoid loss of time, the force was put in place and struck a blow of the required weight to drive it into the heated die blank.

After progressing to this point, the die blank was set up in the chuck of a bench lathe, using an indicator to locate the work from the swaged counterbore in the die, after which an axial hole was drilled, the diameter of which was that of the inscribed circle of the pentagonal hole at the center of clutch *A*, Fig. 1. The next step was to rough- and finish-turn the forward end of the die blank to diameter *D*, Fig. 2, after which the work was reversed end for end in the chuck for rough- and finish-turning the stem to diameter *d*. It will be apparent to all experienced mechanics that the reason for delaying the finish-turning operation until this time is to correct the distortion of the work caused when the force was driven into the heated die blank. With the die blank still held in the lathe chuck with the small end out, a somewhat larger axial hole was drilled almost to the forward end.

It was then necessary to broach the pentagonal hole at the top of the die, which was done with a small five-stepped broach made especially for the purpose. This broach was made from 1/8-inch drill rod, and so it did not possess a great deal of strength; consequently, it was decided to perform the broaching operation by tapping the broach through with a light hammer, which was found to give satisfactory results. Both die *B* and punch *C*, Fig. 3, are made of Ketos steel, and little need be said in regard to making the punch, as it is simply a matter of turning up a blank on the lathe and drilling the clearance hole for swaging punch *D*. This swaging punch was made of steel, with a head upset at the end to provide for mounting it in the die-holder. After the head had been made and turned to size, the punch was hardened and ground to the desired pentagonal form. E. K. H.

* * *

FORD MOTOR CO.'S PROFIT-SHARING PLAN

More than three years have passed since the inauguration of the profit-sharing plan of the Ford Motor Co., at Detroit, under which a minimum wage of $5 a day is paid to employes who comply with certain conditions stipulated by the plan. The results of the profit-sharing scheme have been satisfactory to the company and to the men alike. At the end of the past year, there were, in all, 55,752 employes of the Ford Motor Co. at the home factory and branch factories and offices. Of these, about 42,400 were employed at the Detroit factory. When the profit-sharing plan was inaugurated three years ago, there were 13,500 men on the Detroit factory pay-roll. In the year 1913, 50,448 men left the employ of the company before the adoption of the profit-sharing plan. Last year, only 7512 men left, and of these, 66 per cent had not been with the company for the six months necessary to become profit sharers; hence, the profit-sharing system has largely increased the stability of the working force. Two years ago, the accumulated savings and the property owned by Ford employes amounted to about $18,000,000. At the end of the present year, this sum had increased to about $27,250,000. The company employs nine men in the legal department, which devotes a large share of its time to the interests of the employes. Legal counsel is given free, including advice regarding real estate purchases and investments, to between 150 and 200 employes daily. The medical department employs ten doctors, with twenty-six assistants, giving treatment, surgical and medical, to about 1500 cases a day.

The third year under the profit-sharing plan has been a year of remarkable achievement for the Ford Motor Co. The annual business for the year ending July 31, 1916, was $261,000,000. The standard of 500,000 cars set for production was passed, and during the past winter, the factory has been turning out parts for 3000 cars a day, which are shipped to the various assembling plants, only about forty cars a day being assembled at the factory.

HOURS, FATIGUE, AND HEALTH IN BRITISH MUNITION FACTORIES

According to a recent bulletin issued by the United States Department of Labor, the British Health of Munitions Workers Committee has found that Sunday labor is not profitable and that continuous work is a mistake and does not lead to increased output; that a system of shifts, although impracticable in some cases, is to be preferred to overtime, since the latter taxes the strength of workers too severely, results in loss of time because of exhaustion and sickness, and curtails unduly the period of rest; that night work should be discouraged; that output cannot be maintained at the highest level for any considerable period if the conditions are such as to lead to excessive fatigue and to deterioration in the health of the worker. The committee recommends that the hours should not exceed fifty-six per week for men engaged in very heavy labor, or sixty for men engaged in moderately heavy labor, while sixty-four should be a maximum.

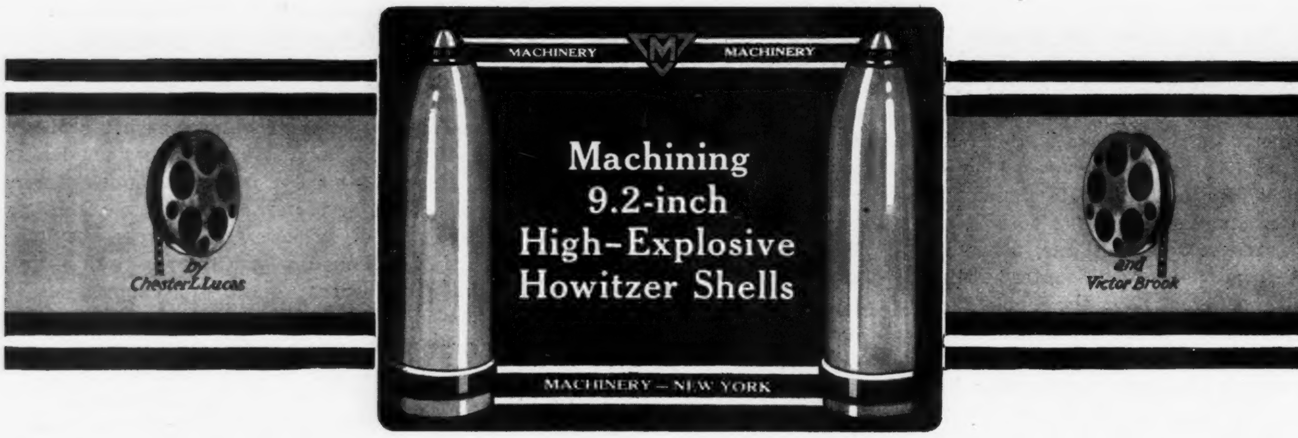
In its report on sickness and injury, the committee says, "To conserve energy and efficiency is, other things being equal, the way to improve output," and recommends the medical examination of all workers before employment. It also suggests that factories should have proper sanitary facilities, safeguarded machinery, arrangements for adequate medical and nurse schemes, etc., and emphasizes the value of first-aid. The committee calls particular attention to the importance of adequate lighting and ventilation, which are absolutely essential for the maintenance of health and comfort, and hence efficiency, of the workers and recommends special measures to prevent undue strain upon eyesight and to reduce the liability of accident to a minimum. Attention is called to the added danger of industrial accidents as follows: "Moreover, at the present time, the introduction of new labor, and of employes unaccustomed to the processes concerned, particularly in conjunction with the need for speed and pressure, overtime and night work, with the consequent fatigue, must inevitably lead to greater risk of accident."

This conclusion corresponds exactly with American experience, as stated in a Safety Bulletin issued by the Utica Mutual Compensation Insurance Corporation, which contained the following:

> The war has caused, indirectly, an enormous increase in the number, severity and cost of industrial accidents, especially during the year 1916. The principal reasons for this large increase of industrial accidents are as follows: the employment of incompetent, unskilled and inefficient labor; the increased pressure for larger output; and the disregard and non-enforcement of safety rules and regulations. During the past few months, the accident rate has been somewhat reduced, because employes have become more accustomed to their work. However, many industrial workers will now enlist to fight for our country, and the services of many skilled workmen will be placed at the disposal of the War Department. To fill their places, employes who are unfamiliar with the work will have to be hired, and women will fill the places of many men called for service. With these changed conditions, there will be even greater necessity for safety measures to prevent accidents.

* * *

The average price of copper for 1916 was slightly over 27 cents a pound, as compared with 17.4 cents in 1915, according to the United States Geological Survey. The year's production, however, surpassed all records. Arizona produced 675,000,000 pounds, as compared with 432,000,000 pounds in 1915; this exceeds the total output of the United States as late as 1902. Montana produced 350,000,000 pounds, about 268,000,000 pounds in 1915 and 314,900,000 pounds in 1912. Michigan's output was about 269,000,000 pounds, and 238,900,000 in 1915. Utah shows an increase of 60,000,000 pounds over the record production of 175,000,000 pounds in 1915. The output from Alaska is estimated at over 120,000,000 pounds; it was 70,600,000 pounds in 1915. Nevada's production reached 100,000,000 pounds, the previous largest output being 85,200,000 pounds in 1913; the output for 1915 was 67,700,000 pounds. The production of New Mexico was 90,000,000 pounds, as compared with 62,800,000 pounds for 1915. California's production exceeded 60,000,000 pounds; in 1915 the production was 37,600,000 pounds. Tennessee's production of 15,000,000 fell slightly below its 1915 production of 18,000,000 pounds.



Machining 9.2-inch High-Explosive Howitzer Shells

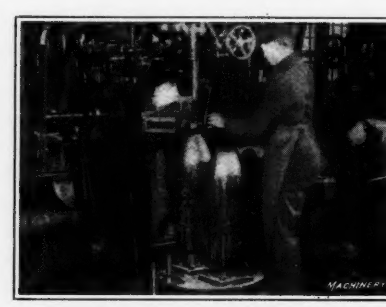
THE following illustrations show the manufacture of 9.2-inch high-explosive howitzer shells as carried on by the A. P. Smith Mfg. Co., East Orange, N. J., who successfully completed a large order recently. The operations include not only the machining of the shell proper, but also the machining of the base plug which ultimately becomes an integral part of the completed shell. Starting with the rough forging, the shell goes through the following operations: drilling and facing nose, cutting forging to length, rough-turning straight section, rough-turning nose, rough- and finish reaming, boring and threading nose, finish-turning, cutting band groove, preliminary inspection, copper banding, boring, reaming and turning base end, washing and drying, hand-tapping nose, varnishing and baking, putting in base plug, band turning, weight cutting, polishing, stamping, final inspection and boxing for shipment. In addition to this, the chief operations in the making of the base plug are illustrated. The base plug is eventually screwed into the base end of the shell and the joint made secure by the use of Petman cement, which is placed on the thread of the plug before insertion.

The approximate cost of the different items making up a complete 9.2-inch shell is as follows: shell body, including forging and material, $57; copper band, $5; bursting charge (36 pounds of T. N. T), $21; fuse, $3; propelling charge (60 pounds), $36; percussion tube, $30; freight, $15; making a total of $167 for the shell as delivered through the muzzle of a field howitzer. The howitzer is a short gun, firing a heavy shell at high angles of elevation.

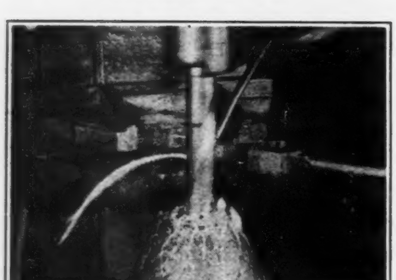
The material for this article consists of representative pictures from a moving picture recently made and produced by MACHINERY entitled "Machining 9.2-inch High-explosive Howitzer Shells." This moving picture is entirely new and marks an advance in industrial educational moving picture films. It was made especially for mechanical men under the direction of mechanical experts. Because of its rare mechanical interest and the timeliness of the subject, MACHINERY considers it a patriotic privilege to offer to show this film gratis before mechanical audiences, and representatives of such bodies are invited to correspond with the Editor of MACHINERY regarding the matter.

The Completed Shell

Shell and Base Plug Forgings

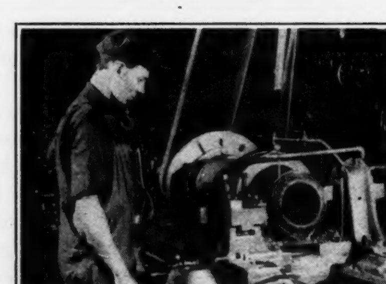


Drilling and facing Nose



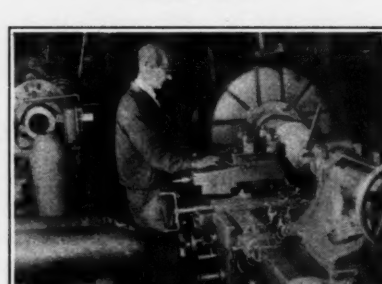
Drilling Nose

Facing Nose



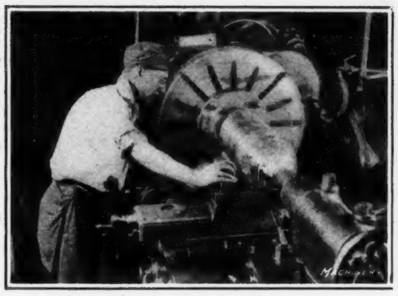
Cutting Forging—

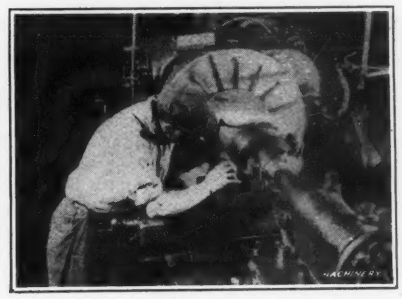
—to Length

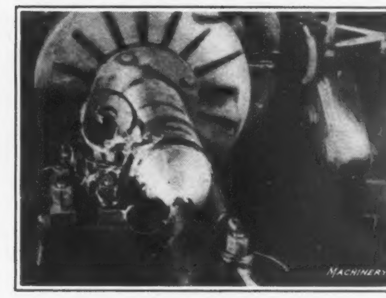


Rough-turning Straight Section

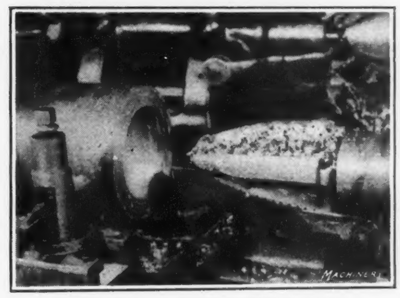
Speed and Feed set at Maximum

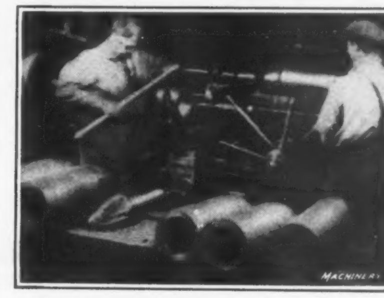

Rough-turning Nose


Gaging Nose

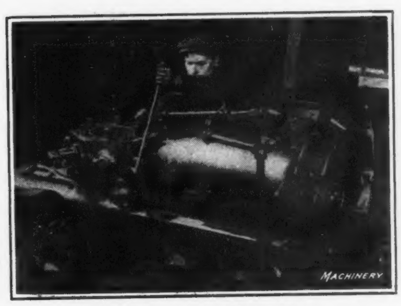

Proceeding at Maximum Speed

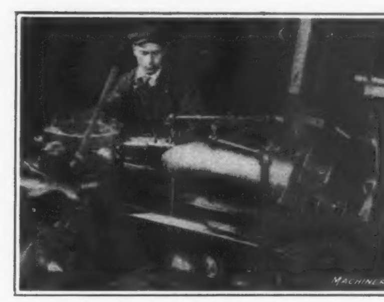

Rough- and Finish-reaming

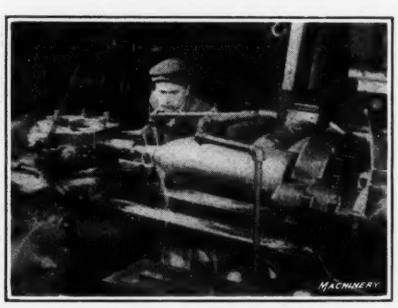

Roughing Reamer, showing Chips

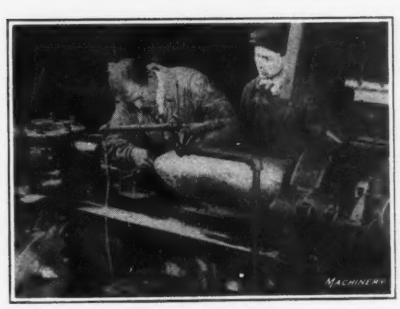

Inspector must O. K. before proceeding


Keeping up the Contour of Reamers

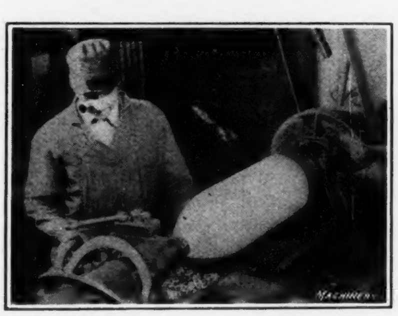

Boring and threading Nose


Bringing Boring Tool into Action


Threading with Collapsing Tap

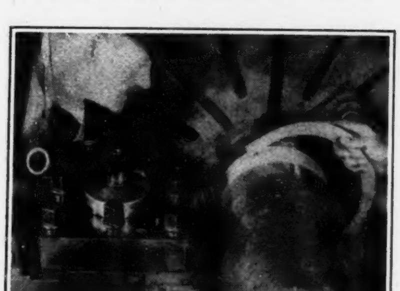

Inspection of Nose


Finish-turning all over


Cam and Follower maintain Shell Contour


Careful inspection after Previous Operation


Cutting Band Groove


Depth of Groove is accurately gaged


Cutting Band Groove requires Two Men

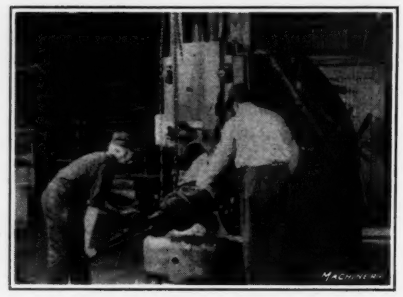

Special Attachment forms Waves

Getting ready for Next Shell

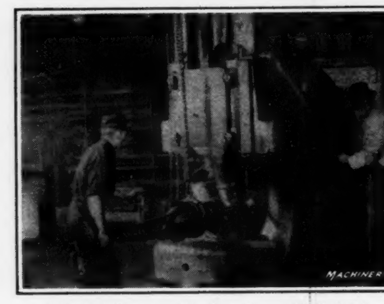
Complete Preliminary Inspection of Shell

Copper-banding Shell

White Hot Band being put into Place



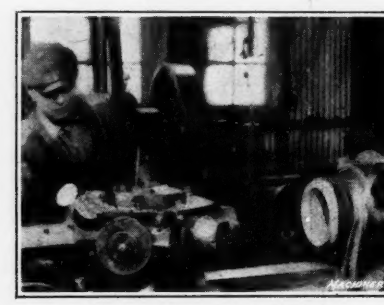
Guiding carefully into Dies on Hammer



Three Blows well placed are Sufficient

Operation Completed—Ready for Another Shell

Boring, Reaming and Threading Base



Indexing Reamer into Position

Reversing Spindle to cut Left-hand Thread

Cleaning out Shell for Inspection

Inspector's Approval Necessary before proceeding

Making Base Plug

Turning and facing Base Plug

Threading Base Plug

Inspecting before removing from Machine

Fitting Base Plug

Applying Prussian Blue to assure fit

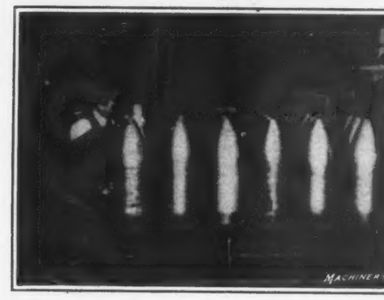
Washing and Drying

Shells are given Two Immersions

Hand-tapping Nose

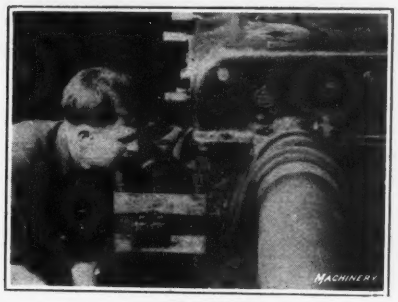
Varnishing and Baking

Shell revolves while Varnish is sprayed



A Truck Load ready to bake

Putting in Base Plug



Band-turning

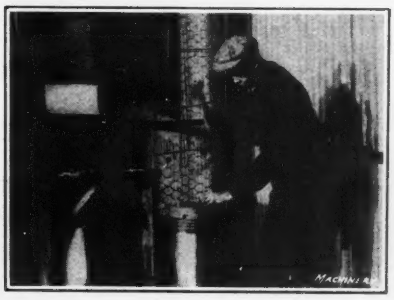
Band Contour governed by Tool in Rear

Inspector's Careful Check is necessary

Weight Cutting

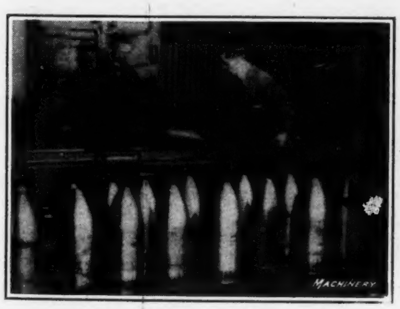
Weight may vary between 250 and 253¾ Pounds

Polishing to remove Rust or Discolorations

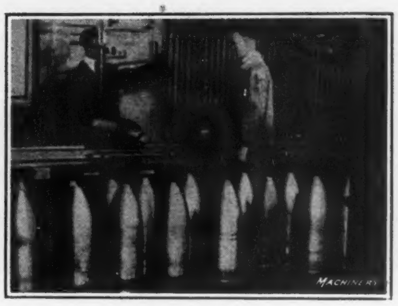


Stamping

Final Governmental Inspection



This is a Most Complete Inspection



Among Other Things, the Weight is checked

Boxing for Shipping

INDUSTRIAL APPLICATIONS OF NICHROME

A NICKEL-CHROMIUM ALLOY HAVING CONSIDERABLE STRENGTH AT HIGH TEMPERATURES AND OTHER REMARKABLE PROPERTIES

BY FRANKLIN D. JONES[1]

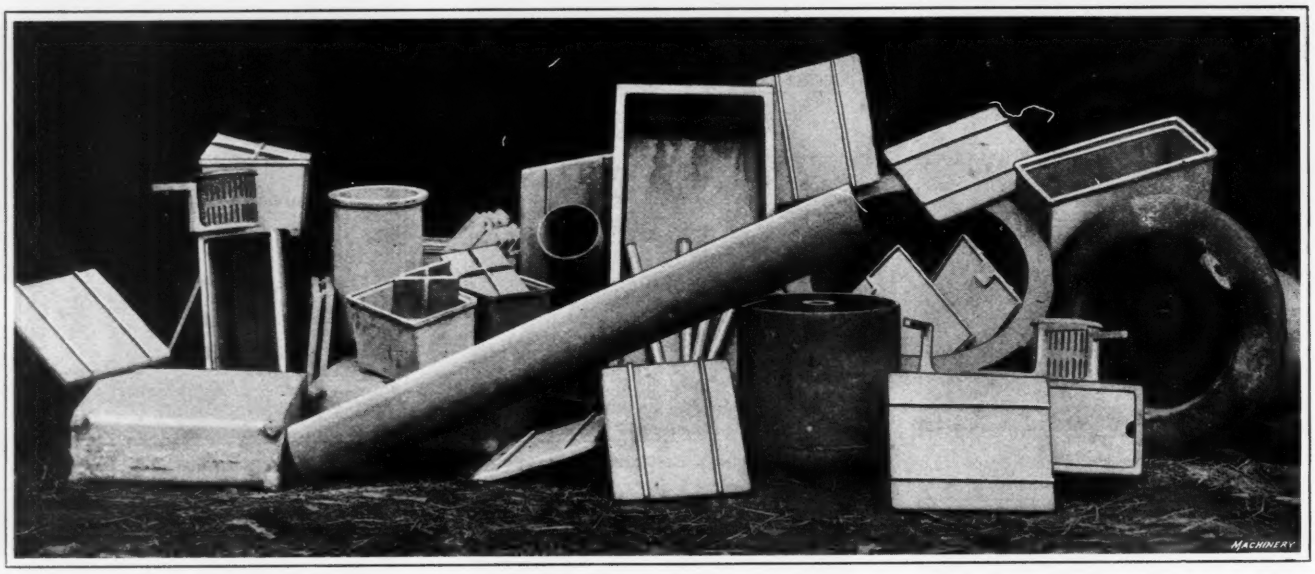


Fig. 1. Collection of Nichrome Castings, including Carburizing Boxes and Tubes, Dipping Baskets, etc.

While it is possible to obtain a metal or alloy having almost any required physical property at ordinary temperatures, the effect of a decided increase in temperature is often highly injurious. The result may be a reduction of strength, a change of form, or oxidation of the exposed surface. If cast iron, cast steel or structural steel is heated above 400 or 500 degrees F., there will be a reduction of strength which will represent a large percentage of the total strength if the temperature is increased sufficiently. Wrought iron begins to lose its strength at temperatures of about 550 to 600 degrees F., and the strength of copper and bronze is reduced if the temperature exceeds approximately 200 degrees F. In some cases, the strength at an ordinary temperature (say, 70 degrees F.) increases within certain limits, and then higher temperatures cause a rapid reduction of strength. For instance, according to one series of experiments, wrought iron at 570 degrees F. was about 16 per cent stronger than at 70 degrees F., but at a temperature of 1475 degrees F. about 85 per cent of the normal strength at 70 degrees F. was lost. Structural steel gained about 32 per cent at 400 degrees F., but lost 72 per cent at 1000 degrees F. The strength of cast iron remained about constant until the temperature exceeded 500 degrees F., and at 1100 degrees F. it had only 58 per cent of the normal strength. While the figures given are subject to some variation because of differences in the composition of the materials of the same class, they indicate one of the injurious effects produced when the materials mentioned are subjected to relatively high temperatures.

Cast iron that is heated and cooled repeatedly undergoes another well-known change, in that it gradually increases in size. This change of size is known as "growth," and it has been the cause of much trouble, especially in connection with cast-iron annealing furnaces, retorts, grates and other equipment or parts that are alternately heated to relatively high temperatures and cooled. Experiments on a test bar 1 inch square and 14 13/16 inches long showed an expansion of nearly 41 per cent as a result of heating and cooling the bar twenty-seven times, the heating period being one hour and the maximum temperature 1470 degrees F. After these tests, the bar measured 1⅛ inch by 1⅛ inch in section and 16½ inches long. In addition to the growth of cast iron, there is also an increase of weight equivalent to approximately 7 or 8 per cent, due to the absorption of gases.

The injurious effect of oxidation previously mentioned is of especial importance in the case of steel and wrought iron. As is generally known, oxidation occurs when the materials are subjected to dampness or prolonged immersion in water, and it is also the effect of heating, since either moisture or an increase in temperature causes the oxygen of the atmosphere to unite more readily with the iron or steel. The result in the case of moisture is corrosion, whereas oxidation of the heated metal causes a scale to be formed on the surface. This scaling mars a smooth or finished surface, and it may also reduce the size of the part, especially if it must be heated repeatedly, as in the case of annealing and casehardening boxes, etc.

The injurious effects referred to may be avoided in many cases by the use of a nickel-chromium alloy known as "nichrome." This alloy has been used for some time in the manufacture of resistance coils for electrical heating apparatus and rheostats, and the physical properties which adapt it particularly for use in electrical work have proved of practical value in various ways. Nichrome is not injured by oxidation of the exposed surface at high temperatures, and it is very strong even when heated red hot, which makes it possible to use this alloy for many purposes for which other materials could not be employed. When nichrome is subjected to an oxidizing atmosphere of high temperature, a slight film of oxide forms on the surface. This film is strong and durable, and resists the action of alka-

Fig. 2. Use of Nichrome Dipping Basket in Connection with Cyanide Bath

[1] Associate Editor of MACHINERY.

lies and of such acids as sulphuric and hydrochloric acid. The oxide is non-flaking and affords additional protection against corrosion or further oxidation. Another noteworthy characteristic of nichrome, especially as compared with cast iron, is that there is no growth or appreciable change of form as the result of alternate heating and cooling.

Nichrome melts at a temperature of about 2800 degrees F. The strength of a nichrome casting, when cold, varies from 45,000 to 50,000 pounds per square inch. At a temperature of 1800 degrees F., nichrome has a tensile strength of about 30,000 pounds per square inch, and it is tough and will bend considerably before breaking, even when heated red or white hot. In order to demonstrate the remarkable strength of nichrome at high temperatures, a cast nichrome plate, approximately ¾ inch thick, was heated red hot and then struck repeatedly with 20-pound sledges upon the unsupported center of the plate. The result was stubborn resistance and gradual bending.

In general, nichrome is adapted for annealing and carburizing boxes, heating retorts of various kinds, conveyor chains subjected to high temperatures, valves and valve seats of internal combustion engines, molds, plungers and conveyors for use in the working of glass, wire baskets or receptacles of other form that must resist the action of acids, etc. Nichrome is the product of the Driver-Harris Co. of Harrison, N. J., and some of the specific applications of this alloy will be referred to in order to illustrate its possibilities as a substitute for other materials, especially where there is difficulty from oxidation, pitting of surfaces, corrosion, change of form, or lack of strength at high temperatures.

Fig. 1 shows a collection of cast nichrome boxes and circular pots for use in annealing or carburizing, and a few other nichrome parts. Up to the present time the use of nichrome for making annealing and carburizing boxes has proved to be one of its most important applications. Boxes made of this alloy are superior to those of steel, principally because they are much more durable. A steel box must be made quite thick to allow for the reduction of thickness caused by scaling or oxidation each time the box is heated. As there is no appreciable loss with a nichrome box, the walls may be made much thinner, thus increasing the conductivity of heat. The durability of steel boxes as compared with nichrome boxes is indicated by the fact that steel boxes of good grade may be used for about 200 or 250 hours, whereas nichrome boxes, under similar conditions, have been known to last about 6000 hours. While the latter are much more expensive, the difference in cost is more than offset by the superior qualities mentioned.

Fig. 2 illustrates the use of a cast nichrome dipping basket and holder, for immersing small steel parts in a cyanide bath having a temperature of 1700 degrees F. These nichrome

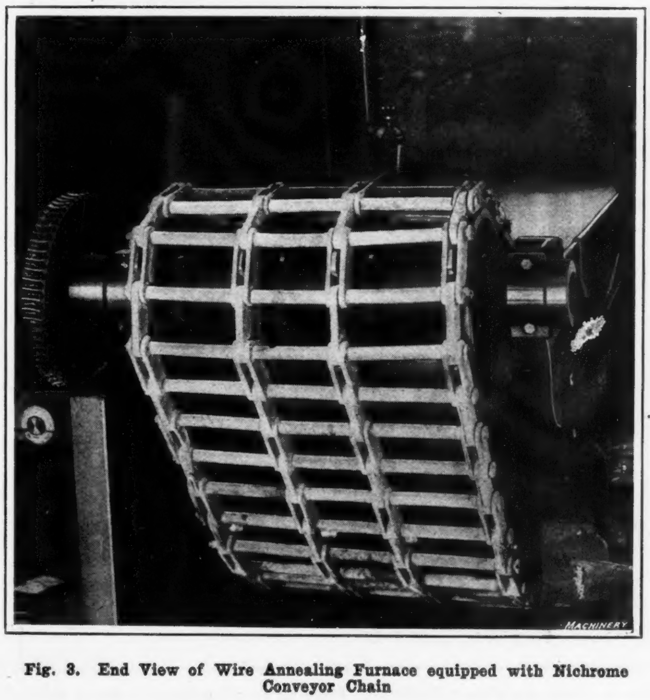


Fig. 3. End View of Wire Annealing Furnace equipped with Nichrome Conveyor Chain

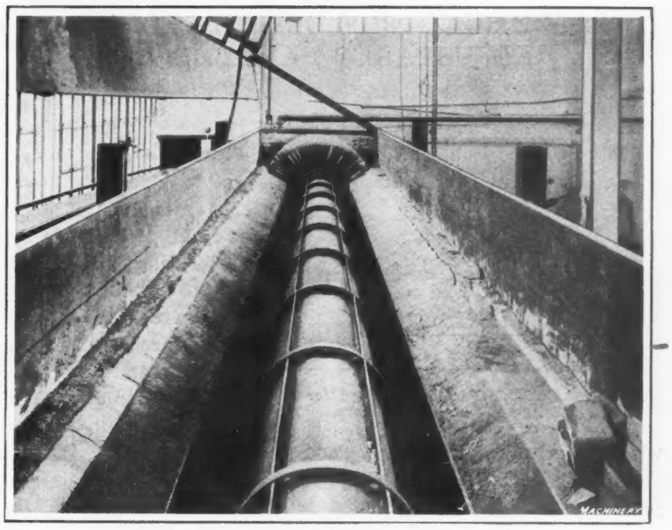


Fig. 4. Nichrome Heating Retort which is kept at a Temperature of about 2000 Degrees F.

baskets (now in use at the Ford plant) are not appreciably affected by the cyanide and do not shrink or lose weight. They are about one hundred times as durable as iron or steel wire baskets.

Another interesting application of nichrome is shown in Fig. 3, which is the end view of a wire annealing furnace. This furnace has an endless nichrome chain to which the bundles of wire are attached, and as this chain moves along very slowly, the wire is carried through the annealing furnace, which is kept at a temperature of about 1600 degrees F. The ends of the furnace are water-sealed to exclude the atmosphere and prevent oxidation of the heated wire. This repeated heating and cooling would soon destroy a chain made of ordinary materials, but a nichrome chain has proved to be very durable. The heating retort shown in Fig. 4, which is subjected to high temperatures, is made of nichrome and is also equipped with a nichrome conveyor chain.

It has been demonstrated that the use of nichrome valves in internal combustion engines eliminates difficulties due to pitting or warping, so that regrinding to prevent leakage is rarely, if ever, necessary. Nichrome valves are of especial value as substitutes for the water-cooled exhaust valves that are used on some engines, especially of the larger sizes, to prevent injuring the valves as a result of excessive heating.

Molds made of nichrome are particularly useful in the manufacture of glass articles, such as bottles. The molds withstand the high temperatures and abrasion, and produce more highly polished glassware, because they can be subjected to higher temperatures than other materials, without difficulty from the molten glass adhering to the mold surfaces. These nichrome molds also resist the chemical action of the elements in the glass. As the molds are strong while hot, they can be made much lighter than cast-iron molds, and they are also more durable.

Crucibles for melting brass and other alloys may be made of nichrome, but its application for this purpose has not as yet been fully developed. While the heat conductivity of nichrome is low as compared with other alloys or metals, it is much higher than that of the graphite or magnesite used for making crucibles. The nichrome crucibles may also be made thinner than those made of the materials mentioned, so that the contents are brought to the melting point more rapidly. The nichrome does not affect the quality of the molten contents, and alternate heating and cooling does not damage the crucibles.

To what extent molds for castings may be made of nichrome has not as yet been fully determined, but experiments indicate that its peculiar properties may prove of great value in connection with this branch of work. Small cast-iron castings poured in nichrome molds have been soft enough to machine, smooth and of close-grained texture. Experiments are to be made in the use of nichrome molds for making shells, the idea being to produce shells very rapidly by casting them with such accuracy as to eliminate many machining processes.

INCREASING THE USEFULNESS OF ADJUSTABLE PARALLELS

BY HARRY P. SIMMONS[1]

The simple device shown in Fig. 1 has proved a great help in solving the problem of spacing and drilling small holes where close limits on center distances are required. Though it is intended for holes too small to be made by the locating button and boring method, for a large percentage of jig and fixture work holes drilled with this tool and then enlarged to size will easily come within the limits of accuracy required.

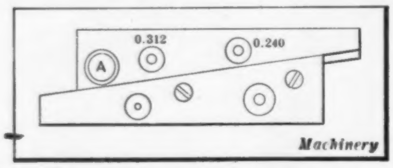


Fig. 1. Adjustable Parallels adapted for Use in drilling Four Sizes of Holes

This device is nothing more than an ordinary Starrett adjustable parallel, with hardened drill-rod bushings inserted in both halves. The bushings are lapped, after insertion, to fit closely drills ranging in size from No. 52 to No. 30. Since the ends of the bushings are flush on both sides, the parallel can be used either side up, and is just as useful for its original purpose as it is without the spacing-jig feature. When the parallel is opened or closed, the relative positions of the holes are naturally changed. With small plugs inserted in a pair of holes in opposite halves of the parallel, it is easy to get the desired center distance with micrometers or vernier calipers. By tightening the screws a solid jig is secured, which may be clamped to the work, and the drilling can be quickly done.

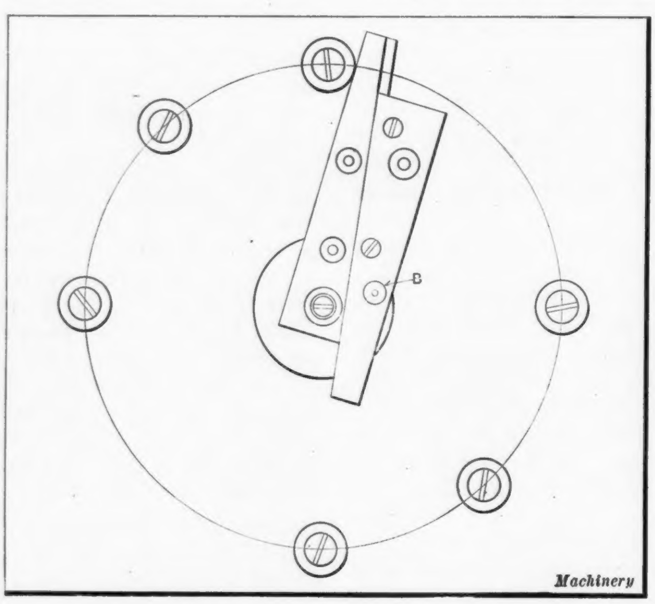


Fig. 2. Use of Parallels for boring Holes in Gear Blanks

In Fig. 1, a bushing *A* with a quarter-inch hole is shown inserted close to one end of the parallel. The bushing is slipped onto a locating button, which is fastened to the work to be drilled by the usual screw, or on a plug set solid in a flat plate, as in Fig. 2. In this case, several 0.063-inch holes were to be drilled on a small radius in gear blanks about 1¼ inch in diameter; the limit of variation was 0.001 inch. Locating buttons were set in a circle around a central plug 0.187 inch in diameter, which was the size of the hole in the gear blanks. It was easy to locate the buttons, getting the required angles between the holes by using the chords of the arcs of the angles between the holes. The parallel was adjusted so that bushing *B* checked the correct distance with the quarter-inch hole in the opposite half of the parallel. A thin bushing was, of course, slipped over the 0.187-inch center plug after the gear blank was in position. The holes were drilled by moving the end of the parallel from one button to the next. The first hole in the blank was drilled through into the plate and a close-fitting pin was inserted to hold the blank in position for the other holes.

Fig. 3 shows the ordinary surface plate with two strips located at right angles along the edges, such as is used by many toolmakers for locating holes in small work with a depth gage against a plug inserted in a small plate clamped to the work to be drilled. The parallel with the bushing will do this work easier and better. The center distance of the holes from the edge of the half of the parallel in which they are inserted should be marked on the parallel. This center distance will, of course, be constant. Then to get the varying distances to the opposite edge as required, it is merely necessary to subtract the constant center distance from the distance from edge to edge, as measured with the micrometer. The parallel should be held on the magnetic chuck of the surface grinder and have the edges nicely trued up before the constant center distances are marked on it.

It is an easy matter to fix up a parallel in the manner described; and since they are made in several sizes, all being the same thickness, it is a good idea to have parallels of different sizes arranged with bushings for small drills. It is better to have different sizes of holes, but all should be small—not over No. 30. Any hole larger than this can easily be brought to size afterward. There is no particular location required in drilling the holes in the parallels for the bushings; but care should be taken to get them squarely through the halves, and have them clean and smooth to receive the bushings. The bushings can be inserted in the split half of the parallel with pressure enough to hold them firmly in position and yet not interfere with the sliding action. A second locking screw has been added to the parallels shown, to make sure that there will be no slipping after the proper position is secured with the micrometers.

When drilling small holes, it is well to remember that a small drill works on the same principle as a large one; just because the cutting edge of a small drill cannot be easily seen is no reason for putting it in the chuck and coming down hard on the lever of the drill press. The cutting edge should be examined with a glass and the drill sharpened with a hone. A good speed should be used. In enlarging the small holes to size, the same rule for care holds good. With a properly sharpened drill, correct speed and a fine feed, it is an easy matter to enlarge the holes to the size required, and still keep the center distance within close limits. The operator should always see that the drill is running true and is accurately centered over the work before permitting it to come in contact with the hole to be enlarged.

* * *

The National Advisory Committee for Aeronautics has defined a right-hand engine as one in which the shaft rotates in a clockwise direction when viewed from the output shaft, looking toward the output shaft end.

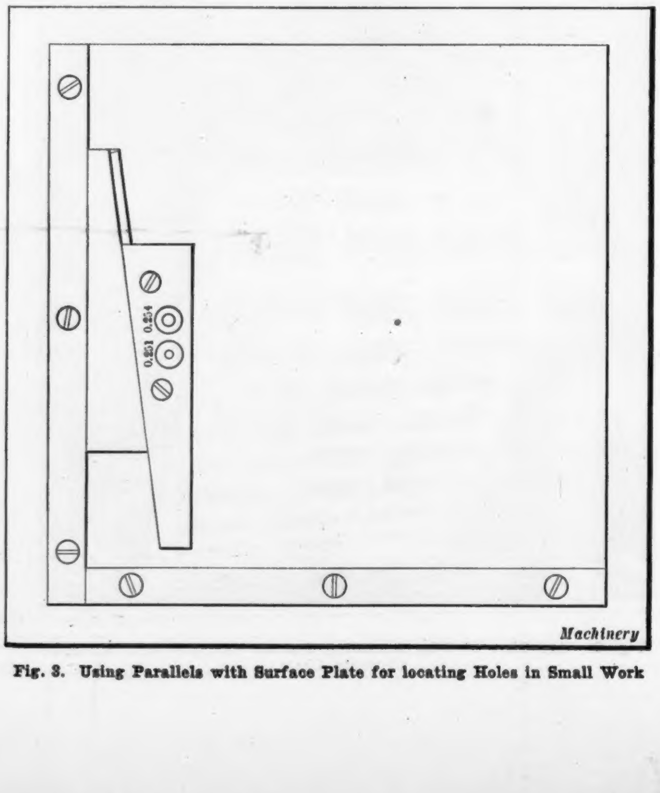


Fig. 3. Using Parallels with Surface Plate for locating Holes in Small Work

[1]Address: 1109 Alberta Ave., Dayton, Ohio.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

MAKING A ONE-PIECE BRASS DOOR KNOB

There are two ways of making a one-piece, pressed, brass door knob; the method here shown is that used by a firm in Waterbury, Conn. The blank *A*, Fig. 1, is a simple job of drawing, and the dies are so well known that no description is necessary. The next five blanks *B*, *C*, *D*, *E* and *F* are made with simple tapering dies, but using a punch with a female taper; they need no explanation except that an annealing operation is necessary between each press operation. The dies for the last two blanks *G* and *H* are of the type known as a fluid or water punch; one is shown in Fig. 2. This die is split along the line *AB* and is held in a holder with a heavy, strong wedge clamp *C*. The punch *D* is a plain, straight piece of tool steel, which is tempered, not because it is subject to wear, but to stiffen and strengthen it. This punch fits snugly in the hole in the stem of the blank.

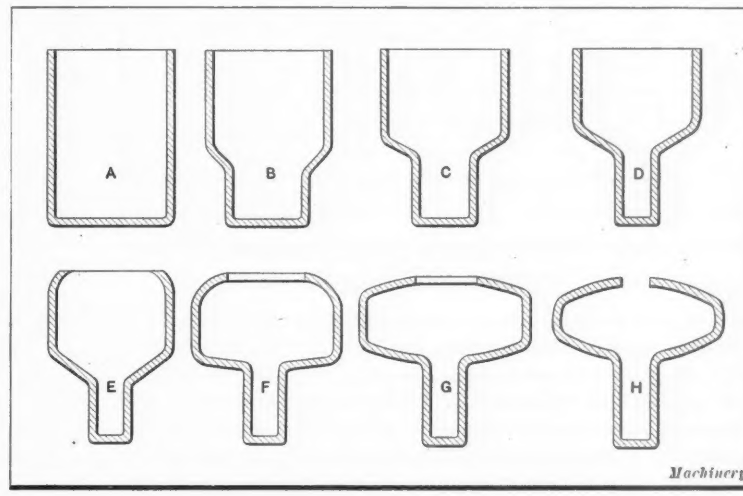


Fig. 3. Alternative Method of making Brass Door Knobs

After the blank *F*, Fig. 1, is placed in the split die, it is filled with water (some prefer oil) and the press is tripped. As the punch *D* enters the stem, it displaces the water, causing it to expand the blank to the shape shown at *G*, Fig. 1. It is possible to swell the blank to the shape shown at *H* in one stroke; but this operation is hard on the clamping fixtures of the dies, and if the metal from which the knob is made is not of the best, the work is likely to rupture. For these reasons blank *F* is pressed into the form *H* in two stages, between which the work is annealed. The operations in both these stages, of course, are the same.

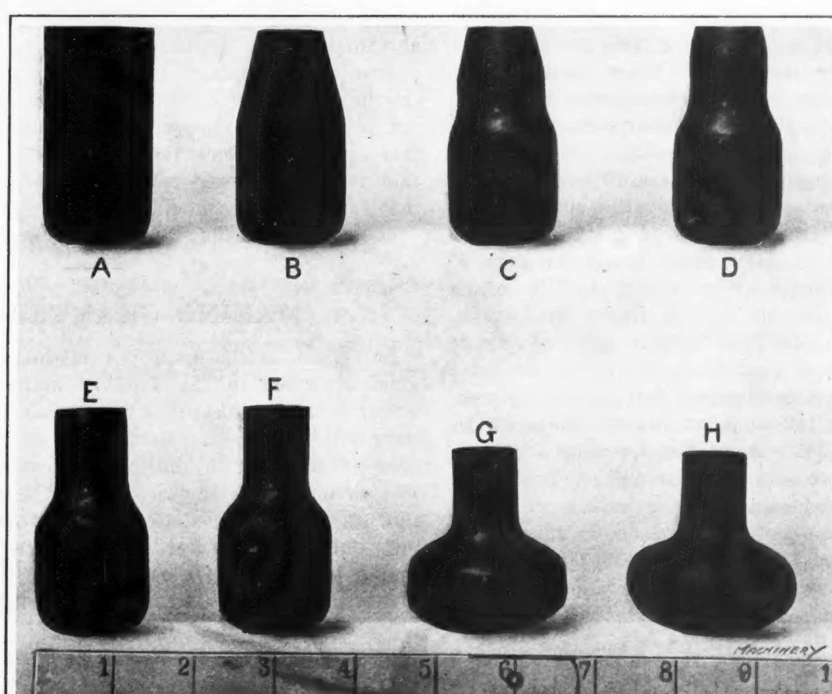


Fig. 1. Steps in making One-piece Brass Door Knob

As the punch descends in the work, some of the fluid is forced out; and as it is under heavy pressure and passes through a small opening, it is likely to be thrown some distance from the press. This trouble and the work of filling each blank are partly avoided by setting the die in a pan that is deep enough to keep the work and die submerged in the fluid. The fluid on the surface retards the upward flow of the water from the work, but does not entirely stop its being thrown about, so a thin brass guard *E*, Fig. 2, is fastened to the punch.

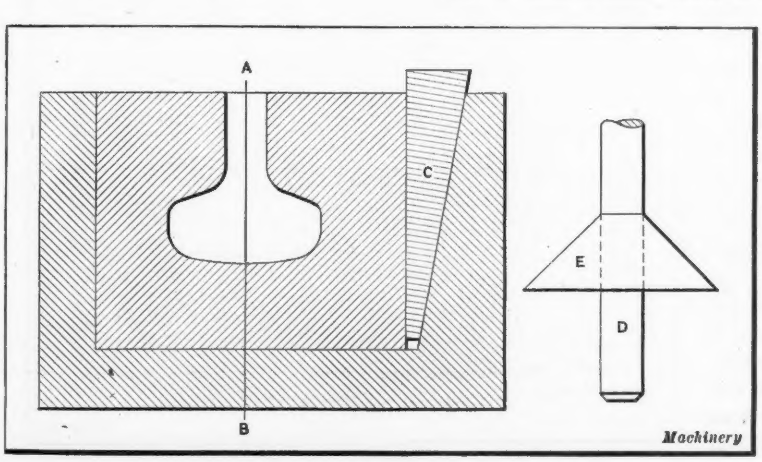


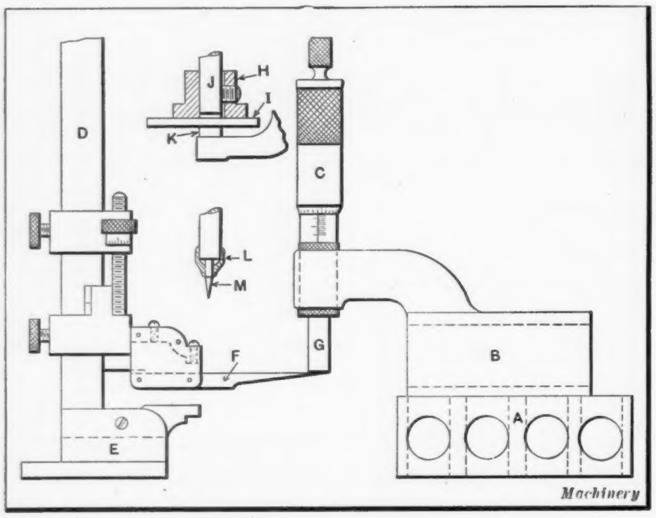
Fig. 2. Dies used for making Door Knobs

A second method of making one-piece, drawn door knobs is shown in Fig. 3. The procedure in this case is somewhat similar to that described, but the reduction in diameter is concentrated on the closed end of the blank until this part is reduced to the desired size for the shank of the knob. Afterward the open end is gradually closed in. It is possible to close the end almost entirely, but it is sometimes left open about 5/8 inch and then turned in the lathe to fit an embossed button, which is soldered or screwed in place.

ROBERT MORRIS

HANDY MICROMETER ACCESSORIES

When a hardened, ground and lapped steel block *A* is used in conjunction with a micrometer *C*, measurements up to 4 inches in height may be taken. This



Handy Micrometer Accessories

block is 1 by 2 by 3 inches, and is perforated as shown to reduce its weight. The micrometer base *B* is 2 inches wide. Parts *A* and *B* were made by a shopmate, who, while suffering from an attack of "farmingitis," sold them to the writer. This tool was so useful to the inspector of gun work at the Sloan & Chace plant that the company had one made especially for his use. The other features shown are of the writer's own design, except *D* which is a Starrett caliper gage. The base *E* of this gage is about 2 inches wide. By means of the detachable point *F*, it is easy to transfer heights from the micrometer spindle *G*; the least contact of the point *F* with the spindle *G* by side motion will move the latter. When used in conjunction with blocks, any height can be found with this gage.

The collar *H* is used for lapping micrometer parts into shape when worn; it is used in conjunction with a flat piece of metal *I*, which must be of uniform thickness. The hole in the collar *H* may be large enough to include the spindle *J* of any micrometer. The collar *H* is fastened to the spindle *J* and then the collar *H*, the piece of metal *I*, and the anvil *K* are brought into contact; the emery or carborundum is on one side only of piece *I*. When the anvil is lapped into shape, piece *I* is reversed and spindle *J* is brought down against it and lapped, anvil *K* acting as a guide.

Parts *L* and *M* require no explanation, being simply attachments to a micrometer for taking point measurements within the limits of a 1-inch "mike." A micrometer with a hole in the anvil would admit of two points at short range. The writer thinks it would be a good idea if some manufacturer would get out a micrometer with a 1- by 1/16-inch stem meeting an adjustable point in the anvil; or with reversible points in the spindle and anvil, each having a square and a pointed end.

Princes Bay, S. I., N. Y. A. H. CLEAVES

PROTECTIVE ELECTROPLATING

The superiority of zinc to other metals as an anti-rust coating for iron and steel is commonly accounted to be due to the fact that zinc is electro-positive to iron. With the exception of cadmium, which is too expensive for general use, all other metals that can be used for commercial protective plating (nickel, copper, brass, etc.) are electro-negative to iron whenever damp penetrates the surface, either by reason of the porosity of the coating or a hole being broken or worn in it. But the superiority of zinc might, on the other hand, be partly due to its being less porous than the other plating metals; to determine this point a series of experiments was recently carried out at the University of Wisconsin.

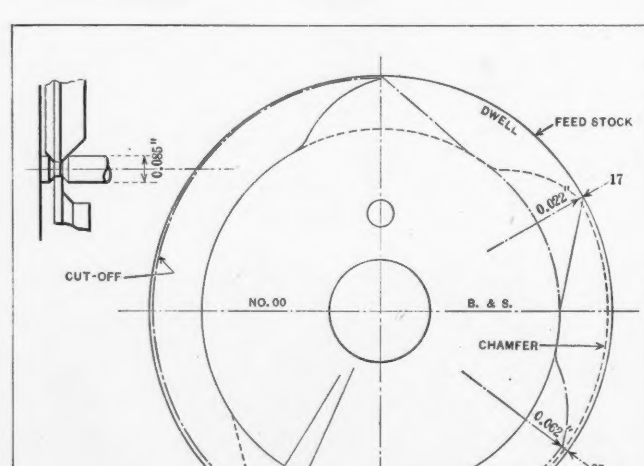
Since it is generally conceded that commercial plating with nickel, copper and brass does not protect iron from rust, it was decided to try much thicker deposits than those usually employed. Heavily plated samples were prepared and subjected to weathering tests. The most striking feature of these tests was the complete protection against rust, during four months of very wet weather, afforded by electro-galvanizing less than 0.0002 inch thick, while rusting occurred through 0.0027 inch deposits of copper, 0.0033 inch of brass, and 0.001 inch of nickel. With thin plating, rusting was serious and widely distributed; but on the thicker deposits, it was confined to a few widely scattered spots. The nickel plate on two samples 0.006 and 0.007 inch in thickness was not only free from rust but appeared as bright as when deposited. The effect of double-plating (a deposit of zinc followed by a deposit of copper or brass) was next investigated, and the samples showed slightly better protection than would be afforded by the same total thickness of brass or copper alone.

The prompt rusting of the iron beneath the thinner deposits of all the metals except zinc seemed to indicate either that such deposits are porous in structure or that there are small holes at certain points that leave the iron exposed. This question was next investigated, and it was concluded that the remarkable protection afforded by very thin deposits of zinc must be due entirely to galvanic action, for thin zinc deposits proved to be as full of holes as were the coatings of other metals. A study of the porosity of electroplating seems to show that deposits of brass 0.00015 inch thick and copper 0.00034 inch thick contain pin-holes. The only hope of a general use of copper and brass plate on iron exposed to the weather seems to lie in securing a uniform deposit free from pin-holes. In special cases it may be feasible to employ the extremely thick deposits of these metals that have been shown to be necessary to protect iron from the weather, but unless the plated article is fairly rigid, there is danger of their cracking and peeling; besides, the time and expense of producing them will prevent their general employment. These experiments confirm the view that the superiority of the electro-galvanizing over deposits of other metals for the protection of iron is due to absence of voltaic action. Deposits of nickel should exceed 0.0015 inch in thickness in order to protect iron out of doors, and copper or brass plate should be three times this thickness. For the protection by electroplating of iron that is to be exposed to the weather, zinc is the only metal that can be used economically.

Liverpool, England MARK MEREDITH

MAKING CHAMFERED PINS

In regard to the improved method of making chamfered pins, described in the January number of MACHINERY, the writer would say that it is unnecessary to come up the second time with the chamfering tool, as this means too great a degree of accuracy in milling the cams and a loss of time. The writer would suggest that the chamfering tool start cutting as soon as the stock is fed out and that the cutting-off tool start a little later, as is shown by the accompanying lay-out of cams. Then as the feed of the cutting-off tool is a little faster than that of the chamfering tool, the former will



Cam Arrangement for making Chamfered Pins

be cutting on the same diameter as the latter when it is through cutting. By this plan the pins will not break off, as the chamfering tool has the same cutting angle. The order of operations is as follows:

Operation	Number of Revolutions of Stock	Hundredths
Feed stock to stop, lead cam	20	17
Chamfer, back-slide cam 0.022 inch stroke, 0.00045 inch feed	50	42
Cut off, front-slide cam 0.062 inch stroke, 0.0008 inch feed	(78)	(65)
Time allowed for cutting off is 0.039 inch stroke at 0.0008 inch feed	49	41
Total	119	100

The spindle speed and surface feet of the stock is the same as in the other method but there is a gain of one second in time, which means quite an item on a quick job. As the time required is only three seconds, the production of 10,800 pins per day of nine hours against 8100 by the other method.

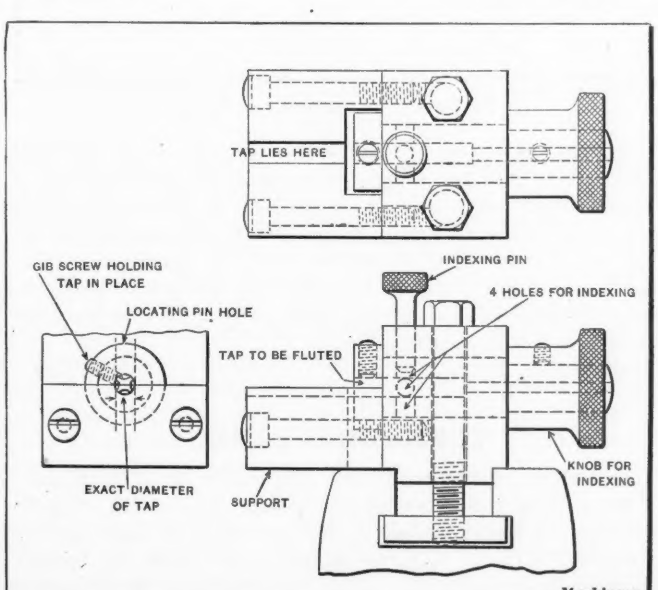
In either case, though, this is only the theoretical production. From this must be deducted the time required to put in each new bar of stock. For instance, a bar of stock is 120 inches long, the length of the piece is 1 inch with $\pm$ 0.005 inch limit, the thickness of the cutting tool is 3/64 inch, and 2 inches of each bar is wasted; it is possible, therefore, to average only 111 pieces per bar. As the time required to make one piece is three seconds, it requires 333 seconds to cut up each bar. Figuring on a nine-hour basis, the operator will not put in a new bar of stock in less than one minute, or sixty seconds; therefore, it will take at least 393 seconds to put in a bar of stock and cut it into the required number of pieces. Adding to this the time required for grinding and resetting the tools, the machine will produce approximately 8500 pins in nine hours, or about 22 per cent less than the theoretical production as given above.

Providence, R. I. HARRY G. BROWN

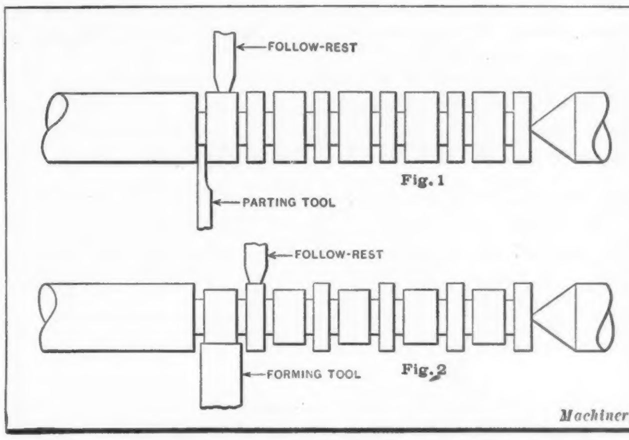
FLUTING ATTACHMENT FOR LATHE

The accompanying illustration shows an attachment for fluting taps in a lathe. The attachment was designed by the writer when it was necessary to flute a number of small taps and it was not convenient to put the work on a milling machine. The semicircular groove in the table is made exactly the diameter of the tap, so when four-fluted taps are being fluted two lands rest on the support. Various sizes of taps can be fluted if bushings are used. While it can be used for three-fluted taps, the attachment is better adapted for four-fluted taps.

Boston, Mass. JOHN A. SHAND



Attachment for fluting Taps in Lathe



Figs. 1 and 2. Advantageous Use of Follow-rest in turning Jig Bushings

USING THE STEADYREST AND FOLLOW-REST

Despite occasional magazine articles on their use, it is apparent to any machine shop man that the steadyrest and follow-rest are not used except when absolutely necessary. They seem to be considered undesirable members that must be kept out of sight as much as possible. The writer was first led to a wider use of the follow-rest by an order to make five or six dozen jig bushings, in two or three sizes. The shop was new and an effort was being made to run before much of the equipment had arrived. The lathe was fitted with a big chuck which had to be shimmed to hold stock smaller than 1¼ inch round, so it was a slow job to feed out and true a bar of stock in the usual way. The writer, therefore, put on the follow-rest and turned up 4 feet of stock to the diameter of the collar on the jig bushings; then, with a parting tool, a series of grooves was cut along the bar, as shown in Fig. 1. The grooves were a little smaller at the bottom than the finished size of the bushing body, which made a neck for the grinding wheel later. Next, with a broad forming tool, the stock was turned out between every other pair of grooves, as shown in Fig. 2. Then the steadyrest was bolted lightly at the left of the lathe carriage, leaving it loose enough so that it could be crowded along with the carriage. The parting tool was set to work to the left of the follow-rest, and the follow-rest jaws were used to steady a drill held in the tailstock in a drill chuck. The bushings were drilled, reamed and countersunk by interchanging tools in the tailstock, and then cut off all nicely necked in for the grinder. A considerable saving could have been made by using special forming tools or holders, but this would have been entirely offset by the cost of making the special devices. Only stock tools and holders were used.

Two steadyrests once got the writer out of a bad fix on a shaft repair. He had been detailed to clean up and put in salable shape a cold-saw machine. While sledging one of the last parts into place, the sledge missed and knocked a small threaded teat off the end of a long drive shaft. As the shaft was longer than any lathe in the shop, the break looked like a bad one. After some pretty hard thinking while taking the shaft out of its bearings, two steadyrests were put on a Hendey lathe, the tailstock removed, and the shaft swung in. Putting the good end on the live center, the shaft was leveled and lined up with a surface gage from the ways, the rest being adjusted farthest from the headstock. Then the jaws of the other rest were set against the shaft, the shaft was turned end for end, a drill chuck was put in place of the live center, and the broken end of the shaft was drilled and tapped, the feeding being accomplished by shoving the carriage against a dog on the shaft. A stud screwed and pinned into the end of the shaft finished the job.

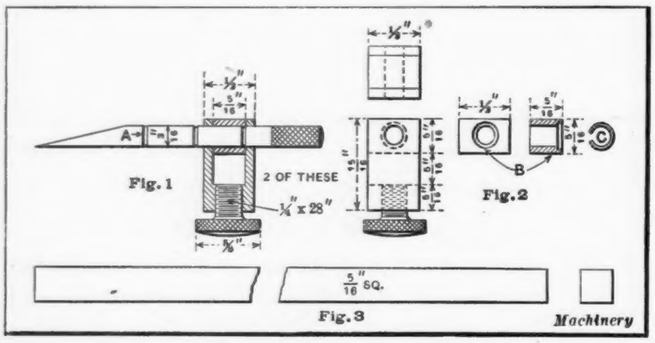
A polishing machine spindle nearly 3 inches in diameter, with a rotor for driving motor in place, was handled in a chuck and two steadyrests, over one-fifth of the shaft extending beyond the lathe. This job was turned end for end when partly done, and called for extreme care, because all work had to be done with reference to the rotor, which was not per-

mitted to run out. This spindle ran 1800 revolutions per minute and swung 20-inch rag wheels. Things had to be pretty nearly right to work well.

Poughkeepsie, N. Y. H. W. JOHNSON

A HANDY TRAMMEL

The trammel here described, which was made by the writer, will be found very handy. One of the trammel points is shown assembled in Fig. 1. The holder, which is ½ inch square, is made of cold-drawn steel. The parts are prevented



Figs. 1 to 3. Construction of Trammel

from falling out when the instrument is being adjusted by a spring *C*, Fig. 2, that fits into the recess *B* and in grooves *A*, Fig. 1, on the beam. Caliper points can also be made if desired. One advantage of this trammel is that as the beam is made of 5/16-inch, square, cold-drawn steel (Fig. 3), it can generally be obtained in any length desired without machining.

S. C.

ASSEMBLING GAS-ENGINE PISTON RINGS

It is sometimes quite a problem to compress and hold piston rings while the piston is being inserted in a gas-engine cylinder. The worst case the writer has met was in a horizontal opposed engine, the pistons of which had to be put in through the crank-case. There was no chamfer at the end of the cylinder bore and the crank-case walls were so close to the pistons that the fingers could not be used to compress the rings so they could enter. After some unsuccessful trials with other methods, the writer wrapped fine wire once around each ring, drawing it tight, so that the ring was compressed to the size of the cylinder. As the piston was pushed into the cylinder, the wire held the rings until they entered the bore, when the wire was cut off.

Poughkeepsie, N. Y. H. W. JOHNSON

MAKING A QUICK REPAIR

The question "How long will it take to make this repair"? is heard in the pattern-shop and in the machine shop every day. In order to make a repair in the shortest time possible, a steel casting is often made to take the place of a hand-forged piece or a piece shaped from a solid bar like a crank-shaft. The writer has made quite a few patterns for cast-steel crankshafts to take the place of forged shafts, and these castings have in nearly every case proved quite satisfactory. In Fig. 1 is shown a triple crankshaft for which a new pattern was made, and a steel casting was produced in twelve hours

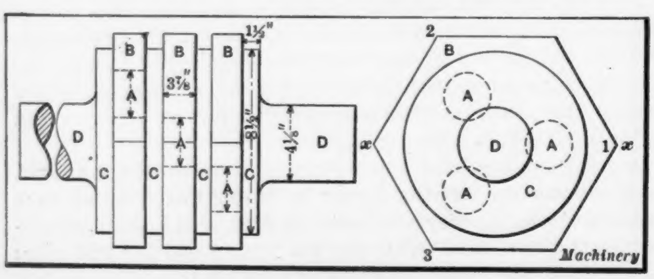


Fig. 1. Pattern of Triple Crankshaft

after the break. Boards for the four disks *C* and the three core-prints *B* were dressed on the planer to exact thickness and cut on the band saw to the correct sizes. These were then assembled and the shafts *D* built on. The pattern was split on the line x–x. A core-box to make the cores *B* was sawed to the exact size on the band saw. The writer had not seen the hexagon core, Fig. 2, used before. The core-box is easily and quickly made and the correct setting of the cores is a simple job. This work must be done accurately, care being taken to cut exactly to the lines marked. The only hand work done on this job was turning the shafts *D*.

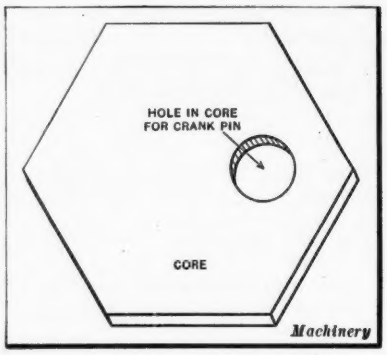


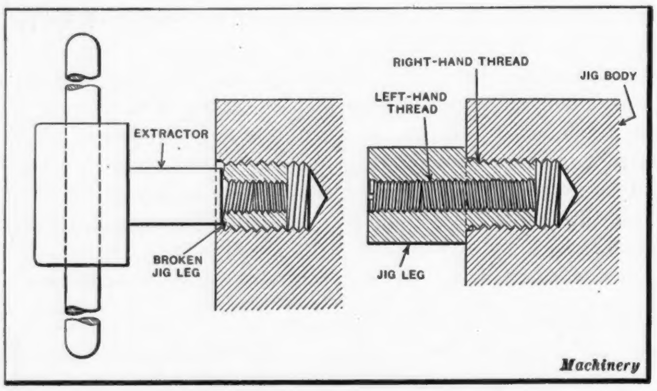
Fig. 2. Core for Triple Crankshaft

Kenosha, Wis. M. E. DUGGAN

EXTRACTING BROKEN JIG LEGS

Some time ago, considerable difficulty was encountered in extracting broken jig legs, and several expensive jigs were practically ruined by locally annealing the broken part of the leg in order to extract it. The jig legs were steel, made glass-hard, except the screw, which was kept as soft as possible; but it is a difficult matter to harden the jig-leg body without hardening the screw to some extent. This is chiefly where the trouble comes in. As the screw is more or less hard, the constant jarring of the legs on the machine table causes them to snap off.

The jig leg here shown was designed to overcome this difficulty. The leg had a 9/16-inch right-hand thread on the outside, and a 1/4-inch hole was drilled vertically through the center. This hole was tapped with a left-hand thread. When the jig legs were screwed into the body of the jig, a special 1/4-inch headless screw was screwed into the leg until it was



Jig Leg and Wrench for extracting it

flush with the bottom of the leg, to prevent chips and dirt from getting into the tapped hole. When a leg broke off, it usually broke near the hole in the jig. A wrench was then screwed into the broken part left in the jig, and when the shoulder of the wrench (which was made smaller in diameter than the leg) came in contact with the broken part, the latter commenced to unscrew. Thus broken jig legs were extracted quickly and easily.

New Haven, Conn. ERIC LEE

THREADING STEEL

The writer read with interest the article by F. E. Metzler in the February number of MACHINERY, on cutting threads. However, he would like to submit what he has been able to accomplish with the 90-degree advance. Although this method has been used mostly in cutting taper threads, it is just as effective on straight work and either internal or external threads.

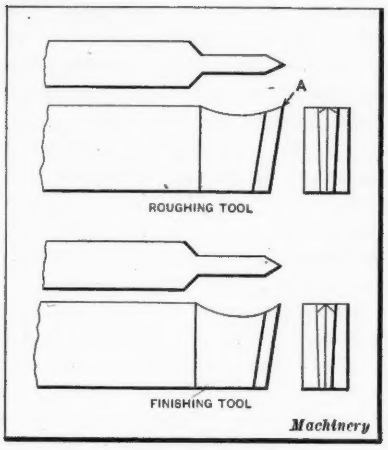


Fig. 1. Roughing and Finishing Threading Tools

The compound rest is set over approximately 30 degrees; the exact angle is immaterial, as the rest is only used to obtain a side movement when setting the finishing tool. The thread is roughed out with the roughing tool shown in Fig. 1. This tool is ground to a sharper angle than 60 degrees, the amount depending on the pitch of the thread to be cut; 50 degrees is correct for an 8-pitch thread in soft steel. The point is also snubbed off, as shown at *A*. With this tool a 7- or 8-pitch thread can be roughed out in two cuts. It will not work well if the second cut is too light; the cut must be heavy enough to keep the chip flowing over the point of the tool so that it will not clog and tear the sides of the thread. The roughing tool for internal work must be ground with as little clearance as possible, so that when the tool springs downward under the force of the cut it will find a bearing on the work and thus be supported. The tool is fed straight in on all cuts.

The thread is finished with the other tool shown in Fig. 1. This tool must have as much rake, or lip, as the nature of the steel will permit. Care must be taken when grinding the tool to the center gage. If the gage is held parallel with the bottom, or shank, of the tool, the thread will not be 60 degrees; nor will it be correct if the gage is held at the same angle as the rake. The tool will be very nearly correct if ground with the gage held about half way between the two. The cuts are taken with the tool fed straight in to the center of the roughed-out thread. The tool will not cut on the point as the first cut is taken, but will act more like a side tool, taking a cut from both sides of the thread at the same time. The first cut should be so proportioned that the next one will clean out the bottom and take a light "skim" from both sides. The thread will now be finished, if the roughing cuts were of the proper depth. Three finishing cuts will be found more satisfactory on internal work because of the spring in the tool. If the lathe is stiff enough and the work is flooded with cutting compound, the finishing cuts on soft steel can be taken at a speed of 130 feet per minute. While this method will not do for precision work, it is satisfactory for ordinary commercial work and is very fast. The object is to feed straight in on all cuts, and finish both sides of the thread at once.

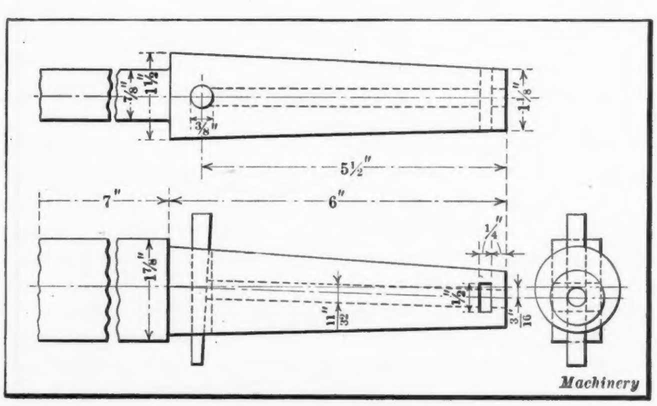


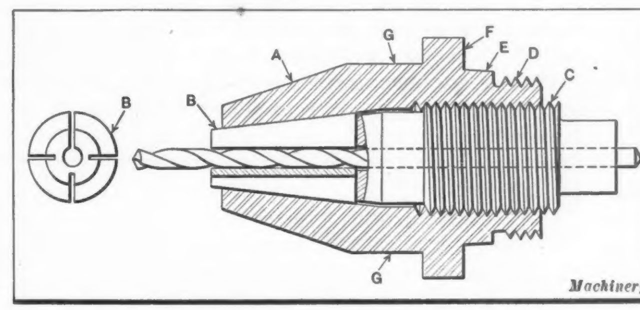
Fig. 2. Threading Bar

In Fig. 2 is shown a threading bar for ¼- by ½-inch tool steel that has the proper balance for good threading. A tool-steel pin inserted in the 11/32-inch hole in the end of the bar, acts in conjunction with the taper pin to hold the tool securely in place.

Los Angeles, Cal. L. J. Bechaud

DRILL CHUCK FOR QUANTITY MANUFACTURING

The accompanying illustration shows a chuck for quantity manufacturing. The body *A* is taper-reamed for the collet *B* and tapped for a screw having a squared end. It is threaded at *D* to suit the spindle of the machine. The thread should be loose enough in the spindle to allow the taper *E* and the shoulder *F* to true the chuck with the spindle. The chuck body is also flattened at *G* for a wrench. The collet *B* must be long enough to hold the drill by the fluted part. It is not feasible to hold a drill by the fluted part in the standard three-jaw chucks, as each jaw grips the drill at a point only, but this collet is long enough to grip the drill for at least the length of one helix, and it is held as securely as if held by the shank. As the chuck is threaded on the shank, instead of having a standard taper shank, it may be removed in a limited space. Accurate drilling can be done with the drill held in the manner described.



Drill Chuck for Quantity Manufacturing

New Britain, Conn. F. E. Potter

USING THE SLIDE-RULE

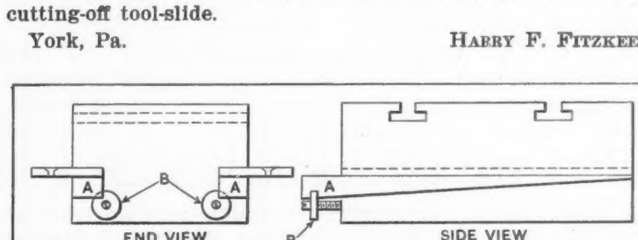
The method of using mixed numbers on the slide-rule that was given in the article "Uses of Slide-rule" in the March number of Machinery is correct, but it requires finding mentally the product of the whole number and the denominator of the fraction. This mental calculation can be avoided by setting the denominator of the fraction on the C scale over 1 on the D scale, and then proceeding as described in that article. Assuming that it is desired to find 2 3/16 on the rule, set 16 on the C scale over the left-hand 1 on the D scale, and then set the rider on the third division on the C scale (corresponding to 35) to the right of 2 on the D scale. It is well to note that this relation holds true regardless of the denomination of the fraction; for instance, if working with feet and inches, it is only necessary to set 12 on the C scale over 1 on the D scale and proceed as before.

Pasadena, Cal. H. L. Doolittle

REPAIRING A CUTTING-OFF TOOL-SLIDE

Although the cutting-off tool-slide of the Gridley multiple-spindle automatic has an adjustment for side play, there is none for wear up and down. The writer, however, has found the following method of repairing these slides very satisfactory: The gib slot in the slide is machined to a taper of one-quarter inch to the foot, and a piece *A* with a corresponding taper is fitted into the slot beneath the gib; this piece is held in place and adjusted by a screw *B*. This method of adjustment, together with the adjustment for side play, gives a rigid cutting-off tool-slide.

York, Pa. Harry F. Fitzkee

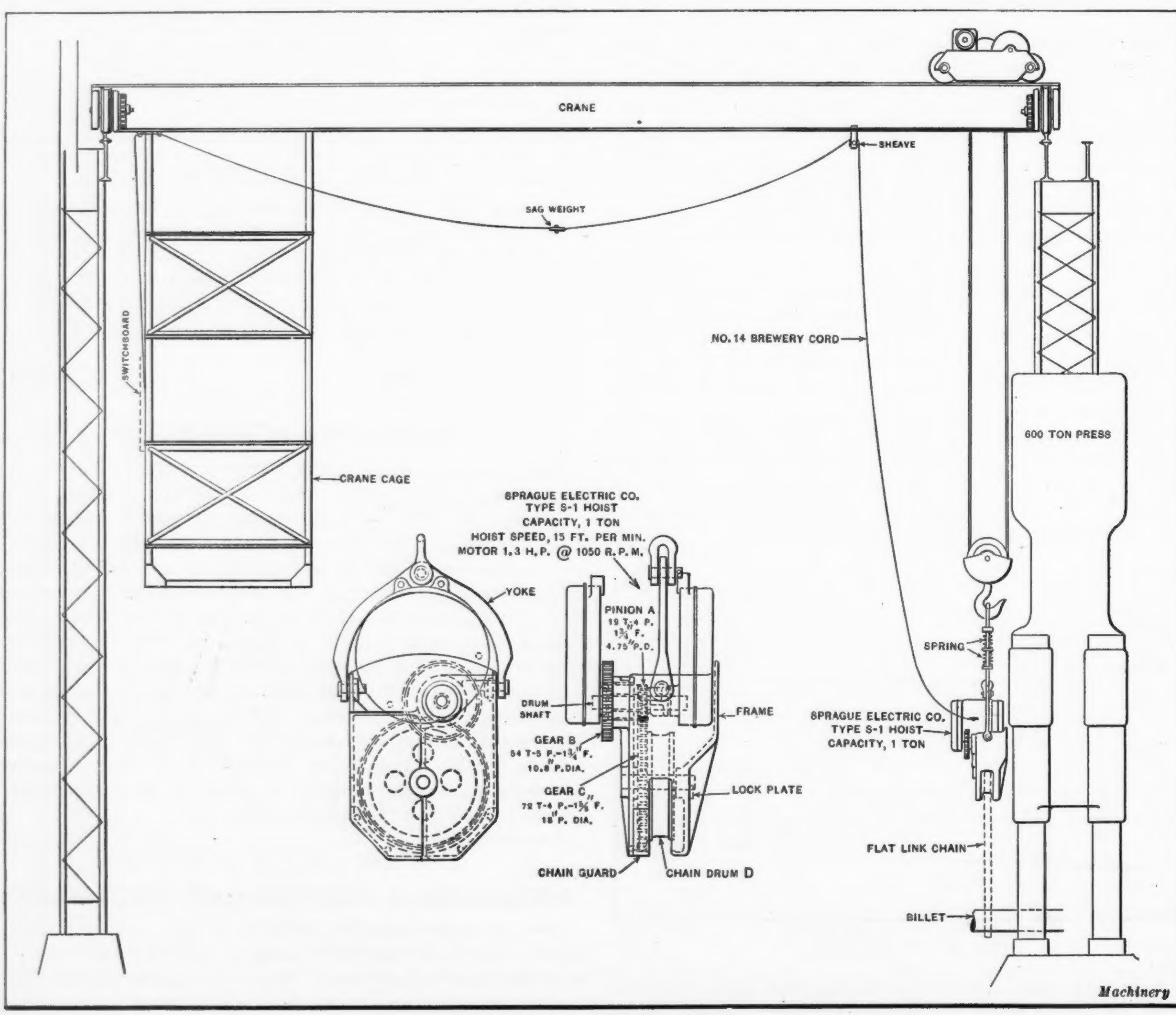


Method of repairing Cutting-off Tool-slide

BILLET TURNING DEVICE

When the sudden demand came for making forgings, some home-made devices had to be used on account of the slow deliveries of market material. The illustration shows an arrangement for turning billets to be forged round under the press. The first plan was to purchase a small motor and make the gears and drum ourselves, but when it was discovered that this required a dynamic brake and controller, which were hard to get in a reasonable time, it was decided to utilize a small one-ton hoist that was not in use, as this had all these requirements combined in one unit.

The cable drum was removed from the shaft and replaced with gear *B* to mesh into the drum-driving pinions of the hoist; gear *B* was keyed to pinion *A* to drive the chain-drum gear *C*. This arrangement gave the proper speed and power in a fairly compact unit, as all were mounted in a casing suspended from the carrying yoke. The crane operator controls this turning device from the cage by means of a switch. The wire is suspended from the crane and arranged in such a manner as to make the line taut at all positions by means of the sag weight, as shown. A flat link chain carries the billet from the drum and rolls it at the operator's will. The large drum contacts give ample resistance against slippage.



Crane arranged as Billet Turning Device

South Milwaukee, Wis. L. D. Peik

A SOCIETY FOR INSPECTORS

Is there a society composed of technical men employed as inspectors? For the past six years the writer has specialized in inspection work; that is, inspecting such work as ordnance materials, automobile parts, machine-shop accessories, and mechanical appliances in general. Since the European War started, he has traveled through different parts of the country, inspecting, mostly, ammunition that was being manufactured by different concerns. This afforded an excellent opportunity to study the different methods, systems and practices in vogue in different shops. After completing the work at one plant, and before proceeding to another, information was generally obtained to the effect that the new place had the facilities of an up-to-date inspection department. But nothing has been found that comes within the meaning of a department devoted exclusively to the inspection of the manufactured product.

It seems strange that so few of the shops and plants visited can say that their inspection department is responsible to the manager for results. Nine cases out of every ten, the inspector is under the supervision of the manufacturing department. Besides, the equipment at the disposal of the men required to keep the product within the limits of acceptance is far from what is actually needed to perform the work in a systematic and efficient manner. The automobile industry, the machine-tool manufacturers, makers of fine tools, and, in fact, nearly all manufacturers have someone who looks after the accuracy and correctness of the finished article. The full value of any inspection department is in proportion to the ability of the men in charge of the department, as well as the equipment and other facilities afforded.

In view of the foregoing, the following questions have suggested themselves: Would an organization composed of men employed as inspectors by different manufacturing concerns have the support of the technical press, engineering societies and manufacturing concerns in general? Would such an organization be of real benefit to the engineering profession as a whole? If such an organization or society were formed, say,

for instance, on the lines of the other engineering societies, would it be possible to secure a membership large and strong enough to warrant its inception?

It would seem to the writer that a society composed of men who test and inspect raw materials, materials in process of manufacture, or the finished article used by the mechanical or engineering professions, that would hold periodical meetings in which it would plan, discuss and adopt standards, methods and systems for doing the work in an economical and efficient manner, educate its members, distribute literature and otherwise further its existence to the best possible interest of engineering and manufacturing would be of inestimable value to the technical world at large.

Woburn, Mass. RUSSELL R. UX

HEALTH INSURANCE

In the December number of MACHINERY, under the title "Health Insurance," Frank F. Dresser presents a plausible argument against health insurance. But to one who has gone more deeply into the subject, it is evident that he has given only a partial presentation. Mr. Dresser evidently fears that health insurance does not improve the public health, and to support this he refers to the fact that the cost of German health insurance has increased since its inception in 1884, that the days of sickness have increased and the duration of illness has lengthened. But he does not state that in the thirty odd years under review, the period for which cash benefits were payable was increased from thirteen to twenty-six weeks, and maternity benefits from four to six weeks; that the basic wage on which cash benefits are computed was raised; and finally, that the total expenditure for medical care had increased seven-fold. That is to say, illness was being cared for more adequately and an increased expenditure was to be expected.

Moreover, figures of this kind drawn from statistics of compensated illness must be used with caution. Such statistics, in the words of Louis I. Dublin, the statistician of the Metropolitan Life Insurance Co., "are largely affected by administrative rulings, and do not always give a true picture of the conditions with which they deal. We are therefore compelled in a measure, to use the facts of death as an index of sickness, realizing that there are limitations to our inferences." The mortality statistics indicate that the health in Germany has been materially improved, for not only has the general death rate been greatly reduced, but the diminution is due in part to the decreasing death rates in the middle-age, or wage-earning age, groups. Moreover, this decreasing death rate for adults in the middle-age groups is a marked contrast to the tendency in this country. For example, in Prussia the death rates among males in the age group from forty to fifty have decreased by 25 per cent in the years between 1875 and 1910; in the United States, on the contrary, mortality rates for males and females between 1880 and 1900 increased in the age group from forty to forty-four by 21 per cent, and in the age group from forty-five to fifty by 22 per cent.

To emphasize the part that social insurance may play in creating sickness, the article states, on the authority of a German investigator, Dr. Ludwig Bernhard, that "before the statute, twenty to forty days were sufficient to heal a fractured collar bone," and that "doctors have had to revise that estimate, since it now takes about eight months." This information is taken from an article by Dr. Paul Dittmer of the Convalescent Hospital, Hanover, Prussia, in which Dr. Dittmer was neither referring to nor casting any reflection upon Germany's social insurance. If Mr. Dresser had gone to the original source, he would have found that Dr. Dittmer was not comparing practice under the insurance with practice either before or after its adoption. Instead, his aim was merely to show the discrepancy between prognoses based upon the time in which the union of a fractured collar bone is medically complete and the time in which a laborer is again able to do heavy work. Dr. Bernhard, by taking Dr. Dittmer's fourteen cases from their context and by omitting his significant statement that "the great difference in estimating the period of healing finds its explanation in the different conceptions as to what constitutes a complete healing," has given Dr. Dittmer's account an interpretation never intended by him.

Since the statement was made that the cost of health insurance is problematical, more light has been shed upon this matter by the reports of the California and Massachusetts Social Insurance Commissions. The California Commission of Social Insurance, with Dr. I. M. Rubinow as consulting actuary, on the basis of six months' intensive study, has come to the conclusion that the cost in California would be 3 1/3 per cent of the wages. In Massachusetts, the cost would be about the same, since there the conditions do not vary enough to substantially influence this figure. The cost of health insurance in Massachusetts, according to Mr. Dresser's estimate, would be about $23,000,000 annually. Of this, the wage-earner would contribute approximately $9,000,000, the employers $9,000,000, and the state about $5,000,000. These figures, large as they are, become less terrifying when we realize that in Massachusetts the workingmen and women pay annually over $12,000,000 to four industrial insurance companies for burial benefits for themselves or their families, and of this sum, only $4,000,000 is returned in funeral benefits. Health insurance would make an important saving in this item of expense.

Health insurance will impose no new burden upon the community, for at the present time it is already bearing the cost of caring for sickness and for the dependency resulting therefrom. The Massachusetts Social Insurance Commission estimates that important savings will be effected in these items. For example, it estimates that out of $12,000,0000 annually spent by the Massachusetts State Board of Charities, at least one-half is expended for sickness under conditions that would be met wholly or in part by the proposed health insurance.

The conclusion of the California Social Insurance Commission is that, "health insurance offers a sensible, practical method of eliminating in part the most distressing features of the present social system, economic dependency and charitable relief. Health insurance would distribute a burden which now means hardship, suffering, and lavish public expenditure, in such a way that it would be a burden no longer."

New York City OLGA S. HALSEY

SHIFTING BELTS ON MOVING PULLEYS

Never shift a belt onto a moving pulley by the old-fashioned method of throwing it with a broomstick or even with a belt pole with a steel pin in the end. If the belt is narrow, that is, up to four or five inches wide, there is a "safety first" belt stick end with three rollers which will enable the operator to throw a belt on or off a moving pulley without danger. Under no circumstances should a belt be put on a pulley by a workman climbing a ladder and throwing it by hand. If the belt is too large to be shifted by means of the "safety first" belt stick, the best method is to stop the power or run very slowly. The belt stick ends are manufactured by two or three concerns. The purchaser should choose the one that is made sufficiently strong and is correctly designed for his work. By enforcing the rule to use them, the manufacturers will avoid many distressing accidents.

Bridgeport, Conn. THOMAS FISH

PAINTING CASTINGS BEFORE MACHINING

Shops depending on foundries without a sandblast equipment usually have to do more or less cleaning on the larger castings. Such castings as machine beds, frames, pedestals, etc., having inside faces that are to be left rough are likely not to be cleaned on the inside—and it really makes very little difference on the finished machine. But when the boring-mill or planer hand gets a cut going on these, the sand begins to loosen with the vibration, and no matter how often he turns the casting, he is troubled with the film of dust that works loose. These faces that shed the dust are ultimately given a coat of cheap paint, so if this paint is put on in the first place and allowed to harden for a couple of days, it will hold all the sand that was not jarred loose at the foundry, and the machine hands will keep cleaner and do better work.

Middletown, N. Y. DONALD HAMPSON

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

SOLVING AFFECTED QUADRATIC EQUATIONS

F. H. A.—When the coefficient of x^2 in an affected quadratic equation is not 1, is it necessary to divide through by it before completing the square? Is there not some way of avoiding the two divisions?

A.—One of the divisions may be changed into multiplication when the following method is used, which is, in general, much easier than the regular method, and the results are likely to be more accurate. Let the equation be $ax^2 + bx = c$;

then, $x = \dfrac{-b \pm \sqrt{b^2 + 4ac}}{2a} = \dfrac{-b \pm \sqrt{b^2 + 4c}}{2a}$, when $a = 1$.

The first value for x is obtained as follows: Multiplying the terms of the given equation by $4a$, $4a^2x^2 + 4abx = 4ac$; adding b^2 to both members, which does not change the equality, $4a^2x^2 + 4abx + b^2 = b^2 + 4ac$. The left-hand member is now a perfect square; hence, extracting the square root of both members, $2ax + b = \pm\sqrt{b^2 + 4ac}$, or $x = \dfrac{-b \pm \sqrt{b^2 + 4ac}}{2a}$.

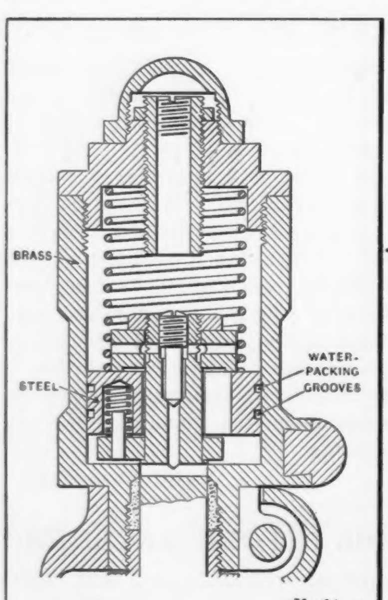
As an example, find x in the equation $2.15x^2 - 9.63x = 20.75$. Substituting in the foregoing expression for x:

$$x = \frac{-(-9.63) \pm \sqrt{9.63^2 + 4 \times 2.15 \times 20.75}}{2 \times 2.15} = 6.0692 + \text{ or } -1.5902 -.$$

J. J.

WATER-PACKING GROOVES

J. B. L.—The accompanying illustration shows part of the oil or regulating chamber of a valve. The piston is grooved, and I would like to obtain information on the theory of action of these grooves in the pistons of dash-pots and other apparatus. What do the grooves accomplish and what are the preferable dimensions for grooves in dash-pots?



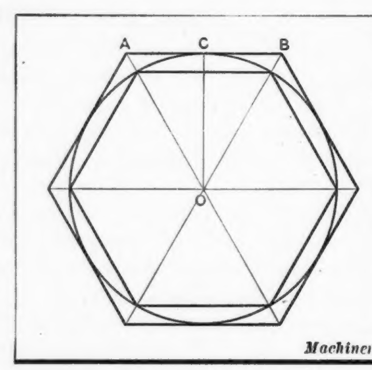
Dash-pot with "Water-packed" Piston

A.—The pistons of dash-pots and similar apparatus that must move with a minimum of frictional resistance are commonly grooved, as shown in the illustration, to reduce the slip or leakage of liquid past the piston. The grooves are commonly called "water-packing" grooves, because water, oil or other liquid under pressure accumulates in the grooves, and by capillary attraction and the setting up of eddy currents materially reduces the leakage of the fluid without causing much frictional resistance. No data are available on the sizes of water-packing grooves, but in general it may be stated that grooves about 1/16 inch wide and 1/16 inch deep are commonly used. Smaller grooves than this are likely to fill up with gum and dirt and become inoperative, while larger ones are not so effective.

RATIO BETWEEN CIRCUMFERENCE AND DIAMETER OF CIRCLE

D. C. F.—Will you kindly explain the derivation of π, or 3.1416? What I should like to know, if possible, is how it was originally derived.

A.—The first person to calculate the value of π by a purely mathematical process was Archimedes (287-212 B.C.). Before the invention of the calculus (less than 300 years ago), it was customary to use the method of exhaustions in connection with problems that could not be solved by ordinary means, and this was the method used by Archimedes. Referring to the illustration, a regular polygon is shown inscribed in and a similar one circumscribed about a circle. It is evident that if the number of sides of both polygons is doubled, the difference in their areas will be diminished, and the areas of the polygons will more nearly equal that of the circle. If this doubling is continued indefinitely, the area between the polygons will be exhausted, and the area of the polygons will finally become, as nearly as we please, equal to that of the circle; at the same time, the perimeters will approach the periphery of the circle. This was the method used by Archimedes. Starting with a polygon of six sides, he doubled until he had reached a polygon of ninety-six sides. Taking the diameter of the circle as 1, the perimeter of a regular inscribed hexagon is 3 and of a similar circumscribed hexagon is $2\sqrt{3}$, since $AC = \tan 30$ degrees $= 1/3\sqrt{3}$. Denoting the perimeter of the regular circumscribed polygon by P, and of one having twice as many sides by P_1, and letting p and p_1 represent the perimeters of similar inscribed polygons, it is proved in geometry that $P_1 = \dfrac{2pP}{p + P}$, and $p_1 = \sqrt{pP_1}$. By means of these two formulas, the perimeters of polygons of twelve sides are calculated; then they are applied again to polygons of twenty-four sides, to forty-eight sides, to ninety-six sides, etc. The values given in the following table were obtained by using a table of logarithms. Archimedes proved that the value of π was less than



Original Method of calculating Value of π

PERIMETERS OF POLYGONS

Number of Sides	P	p
6	3.46410	3.00000
12	3.21539	3.10584
24	3.15965	3.13262
48	3.14608	3.13934
96	3.14271	3.14103

Machinery

3 1/7 and greater than 3 10/71. By using a greater number of decimal places and extending the number of sides to 12,288, P, p and π will agree to seven places of decimals. By means of infinite series, modern calculators have computed π to 730 decimal places and have proved that it is incommensurable and transcendental.

J. J.

HYPERBOLIC LOGARITHMS

G. N. E.—In MACHINERY'S HANDBOOK there is a table of hyperbolic logarithms; how can I find the logarithm of numbers less than 1 and, also, of numbers greater than 10?

A.—As $\log a = \log \dfrac{ac}{c} = \log ac - \log c$, when the number is less than 1, multiply it by some convenient number, preferably 10 or some power of 10, that will make the product come between 1 and 10; find the logarithm of the product by means

of the table, and then subtract the logarithm of the number used as a multiplier. For example, $\log_e 0.7854 = \log_e 7.854 - \log_e 10 = 2.0610 - 2.3026 = -0.2416 = \bar{1}.7584$. If the number is greater than 10, $\log a = \log\left(\frac{ac}{c}\right) = \log\frac{a}{c} + \log c$; hence, divide the number by some number, preferably 10 or a power of 10, that will make the quotient come between 1 and 10; find the logarithm of the quotient by means of the table, and then add the logarithm of the number used as a divisor. For example, $\log_e 217.64 = \log_e \frac{217.64}{100} + \log_e 100 = \log_e 2.1764 + \log 100 = 0.7776 + 4.6052 = 5.3828$. It is not advisable to use the table for finding the logarithms of numbers between 10 and 100 by interpolation, as second differences will usually be necessary, and the method here given is much easier and, in general, more accurate. The hyperbolic logarithm of any power of 10 may be found by multiplying 2.302585 by the exponent. Thus $\log_e 10{,}000 = \log_e 10^4 = 2.302585 \times 4 = 9.21034$.

J. J.

A PROBLEM IN GEARING

F. A. N.—In the accompanying illustration, the circles represent the pitch circles of gears, the diameters being as follows: gear *A*, 3.382 inches; gear *E*, 0.441 inch; gear *B*, 1.650 inch; gear *C*, 0.322 inch. The angle $FMD = \phi$ may be any angle, but in this case it is 45 degrees. Please show how to calculate the distances *MD*, *DI*, *JP* and *PI*, *ND* and *JI* being perpendicular to *MD*, *ND* perpendicular to *MD*, and *RS* tangent to gears *A* and *E*.

A.—Draw *PL* parallel to *MD*. Since *RS* is perpendicular to *MN*, angle $LHG = FMD = \phi$. Angle $LKP = LHG + GFP = \phi + 14\frac{1}{2}$ degrees $= \phi + 14$ degrees, 30 minutes, and angle $KPL = 90$ degrees $- (\phi + 14$ degrees, 30 minutes$) = 75$ degrees, 30 minutes $- \phi$. Hence, when ϕ is known angle *KPL* is known. Angle $PFN = 90$ degrees $- 14$ degrees, 30 minutes $= 75$ degrees, 30 minutes; $NF = 0.441 \div 2 = 0.2205$ inch; $NP = (1.650 + 0.322) \div 2 = 0.986$ inch; hence, in the triangle *PFN*, one angle and two sides are known, and the angle *NPF* can be found. Angle $NPL = NPF + KPL$, and as *NP* is known, *NL* ($= JP$) and *LP* ($= DI$) are readily calculated. $MN = (3.382 + 0.441) \div 2 = 1.9115$ inch, and since the angle ϕ is known, *MD* and *ND* are readily calculated. $PI = ND - NL$. In the present case, $\phi = 45$ degrees; consequently, from the foregoing, angle $KPL = 75$ degrees, 30 minutes $- 45$ degrees $= 30$ degrees, 30 minutes. In triangle *PFN*, $\sin NPF = \frac{NF}{NP} \times \sin PFN = \frac{0.2205}{0.986} \times \sin 75$ degrees, 30 minutes $= 0.21651$; from which angle $NPF = 12$ degrees, 30 minutes, 14 seconds, and angle $NPL = 30$ degrees, 30 minutes $+ 12$ degrees, 30 minutes, 14 seconds $= 43$ degrees, 14 seconds. $NL = NP \times \sin NPL = 0.986 \times \sin 43$ degrees, 14 seconds $= 0.67250$ inch. $LP = 0.986 \times \cos 43$ degrees, 14 seconds $= 0.72107$ inch. $MD = 1.9115 \times \cos 45$ degrees $= 1.3516$ inch. $ND = 1.9115 \times \sin 45$ degrees $= 1.3516$ inch. Finally, $LD = PI = 1.3516 - 0.6725 = 0.6791$ inch.

J. J.

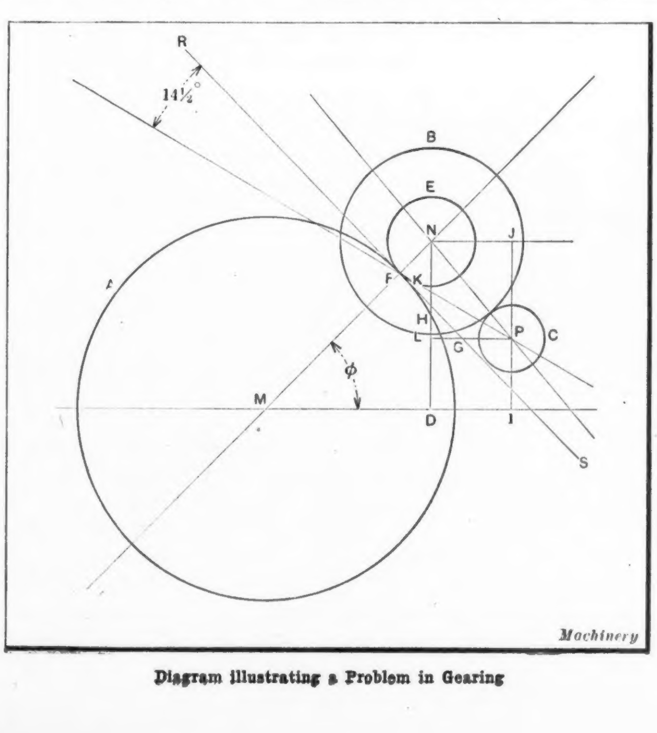


Diagram illustrating a Problem in Gearing

COMPOSITION AND USE OF GUN-METAL

O. G.—What is gun-metal, and for what purpose is it used?

A. Gun-metal or gun-bronze consists of about 90 per cent of copper and 10 per cent of tin with small percentages of lead, iron and zinc. The composition called for by the United States Navy specifications is: Copper, from 87 to 89 per cent; tin, from 9 to 11 per cent; zinc, from 1 to 3 per cent; iron, not exceeding 0.06 per cent; and lead, not exceeding 0.2 per cent. The mixture formed of copper, 88 per cent; tin, 10 per cent; and zinc, 2 per cent, is variously known as "zinc bronze," "Admiralty metal," "government-bronze," and "88-10-2 alloy," although these terms are also frequently applied to all gun-metals. The castings made from gun-bronze are improved by the addition of a small amount of zinc, and the alloy is made harder by the presence of a small percentage of iron, while the small percentage of lead present makes an alloy that is more easily machined. The tensile strength of gun-bronze is from 25,000 to 35,000 pounds per square inch. The United States Navy specifications require a minimum tensile strength of 30,000 pounds per square inch. The elastic limit varies from about 15,000 to 17,000 pounds per square inch, and the metal withstands severe shocks without fracture. The minimum elongation should be about 15 per cent in two inches. Gun-metal is used as a bearing metal and for a great many other purposes, such as valves, valve seats, flanged pipe fittings, etc., where exposed to the action of the sea water.

The following compositions of gun-metal are used in British practice:

1. Copper, 88 per cent; tin, 10 per cent; zinc, 2 per cent. This alloy is known as "Admiralty steam metal." The alloy should have a tensile strength of not less than 22,000 pounds per square inch, and an elongation of 7.5 per cent in two inches. Sometimes this mixture will have a tensile strength up to 32,000 pounds per square inch with an elongation of 14 per cent.
2. Copper, 88 per cent; tin, 11 per cent; zinc, 1 per cent. This alloy is also used for naval work.
3. Copper, 87 per cent; tin, 8 per cent; zinc, 5 per cent. This alloy is used for propeller castings.
4. Copper, 87.5 per cent; tin, 6.25 per cent; zinc, 6.25 per cent. This alloy is used for bolts and has a tensile strength of 30,000 pounds per square inch, with an elongation of about 23 per cent in ten inches when cast in dry sand.
5. Copper, 84 per cent; tin, 12 per cent; zinc, 4 per cent. This mixture is used as a bearing metal for marine work.

The ductility of gun-metal castings is increased by heating them in a muffle furnace to from 1100 to 1500 degrees F., for about thirty minutes, and then cooling them slowly; frequently the castings are quenched in water.

STRENGTH OF BLANKING-DIE HOLDER

G. McI.—Fig. 1 shows a design proposed for a block or holder for a blanking die. The die proper is made in two parts, the split being on the line *A—B*. Can you give me a formula for similar constructions to determine the thickness of metal around the die at *T* and *t* necessary to support the die on the sides and to bridge over the gap in the frame? The material to be blanked in the present case is 0.40 to 0.50 carbon steel, ⅜ inch thick, but I would like a formula applicable to other forms and thicknesses.

Answered by John S. Myers, Philadelphia, Pa.

The proportions of such constructions are generally based on experience of similar cases, rather than on mathematical analysis. On account of the uncertainties involved, precise treatment seems impracticable. The method of procedure is to make a drawing of such size as judgment dictates and then apply some rough-and-ready analyses for strength based on

fairly reasonable assumptions. Such a treatment of the problem submitted follows:

Let C = circumference or perimeter of blank to be sheared;
t = thickness of stock;
S = ultimate shearing strength of stock;
P = power or load on punch required to shear out blank.

Then:

$$P = CtS, \text{ approximately} \tag{1}$$

For the present case, C = 26.17 inches, t = 0.375 inch, and assume S = 65,000 pounds. Then $P = 26.17 \times 0.375 \times 65{,}000 = 638{,}000$; say, 640,000 pounds.

Now, under the action of a punch, the natural line of failure due to shear is along oblique lines, such as AB and CD, Fig. 2. This is indicated by the form of punchings from heavy plates. The die, however, restrains the plate on the under side and compels ultimate failure to take place along lines having less obliquity, as EM and GH, Fig. 3. The perpendicular force P may thus be considered to have some resultant direction, such as JL and JK, where it acts upon the die, giving a component F that represents the outward thrust or crowding action upon the die. Assuming the angle α to be in the neighborhood of 18 degrees, we may take this total crowding action as approximately:

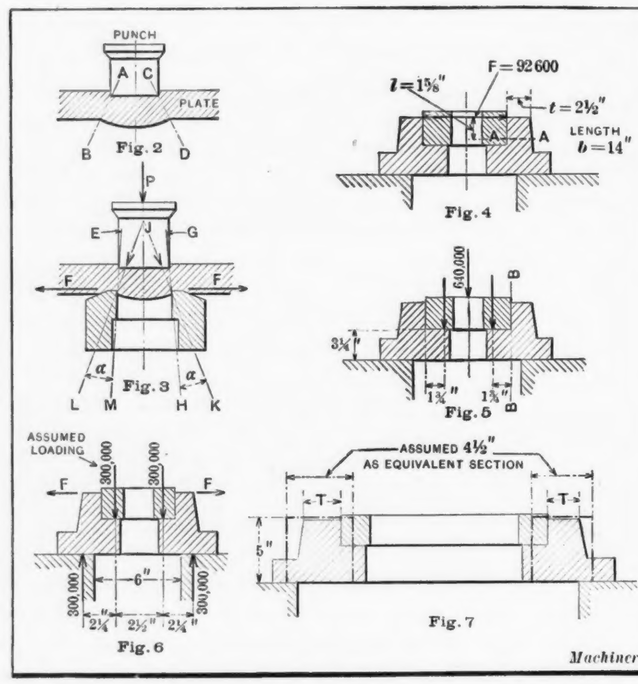
$$F = 1/3\,P \tag{2}$$

Then $F = 1/3 \times 640{,}000 = 213{,}000$ pounds.

The amount of this action on each side of the die may be taken in the proportion of the projected length of the blank to its total circumference C. Then the crowding force F in Fig. 4 is $F = \dfrac{11.375}{26.17} \times 213{,}000 = 92{,}600$ pounds. The shearing stress on a section of the holder, such as at A–A, Fig. 4, is then $S_s = \dfrac{F}{tb} = \dfrac{92{,}600}{2.5 \times 14} = 2640$ pounds per square inch. The bending moment upon this section is $M = Fl = 92{,}600 \times 1.625 = 150{,}000$ inch-pounds. The section modulus is $Z = \dfrac{bt^2}{6} = \dfrac{14 \times 2.5^2}{6} = 14.58$. The bending stress is then $S_b = \dfrac{M}{Z} = \dfrac{150{,}000}{14.58} = 10{,}300$ pounds per square inch.

In Fig. 5, the area in shear on section B–B, for the entire block, is $A = 3.25 \times 37.25 = 121$ square inches. The shearing stress is then $S_s = \dfrac{P}{A} = \dfrac{640{,}000}{121} = 5290$ pounds per square inch. The bending moment on this section, taken on the total periphery of the die, is approximately $M = 640{,}000 \times 1.75 = 1{,}120{,}000$ inch-pounds. The section modulus is $Z = \dfrac{37.25 \times 3.25^2}{6} = 65.6$. The bending stress is then $S_b = \dfrac{1{,}120{,}000}{65.5} = 17{,}070$. This seems high, and it indicates that the holder might with advantage be made thicker underneath the die; however, failure may not occur here, as part of this bending may be sustained by the die itself.

Fig. 1. Blanking Die and Holder



Figs. 2 to 7. Diagrams used in determining Strength of Die-holder

For the thickness of metal on the ends at T, Fig. 6 indicates an assumed loading as a beam from which the bending moment is $300{,}000 \times 2.25 = 675{,}000$ inch-pounds. Fig. 7 indicates the section sustaining this bending as being approximately equivalent to a rectangular section 9 inches wide by 5 inches deep. The section modulus is then $\dfrac{9 \times 5^2}{6} = 37.5$, and the bending stress is $S_b = \dfrac{675{,}000}{37.5} = 18{,}000$ pounds per square inch. Actually, the crowding components F develop a bending moment that opposes this, thus reducing the stress. The actual value of this force F is, however, largely a matter of conjecture, Formula (2) arbitrarily assuming a value which was considered to be high enough for safety when this force F acts as a bursting force. In the present instance, it is probably best to neglect this crowding action. As stated, the designer must rely largely upon judgment and experience in such cases, but the foregoing shows, in a general way, how such constructions may be roughly checked for strength.

* * *

TASK-AND-BONUS SYSTEM IN ENGINEERING EDUCATION

At the College of Engineering of the University of Minnesota a new educational experiment is being tried in the application of the task-and-bonus plan to the departments of shop work and design. Every job given to a student carries with it the time allowed, which is estimated on a fair basis. Any time saved by the student is given to him as a credit by means of which his time in college may be shortened, if he accumulates a sufficient amount. It is assumed that the best men can save one-third of the time; and, on the other hand, if they prefer to do more work and not use the credit in reducing the time spent on the subject, they can get one-third more value out of the course. Prof. J. J. Flather reports that the system is working well both in the shop and drafting-room, and that all the instructors are enthusiastic in its application. The output per individual is at least 25 per cent and in some cases 50 or 60 per cent more than was the average before the scheme went into effect. There is an increased enthusiasm on the part of the men; their ambition is stimulated, and no drop in the quality of the work has been apparent. In fact, there is a strong tendency to maintain a high standard, because additional credit is given for superior work, and an extraordinarily good man may earn one-third bonus for quality in addition to the bonus he may earn for quantity.

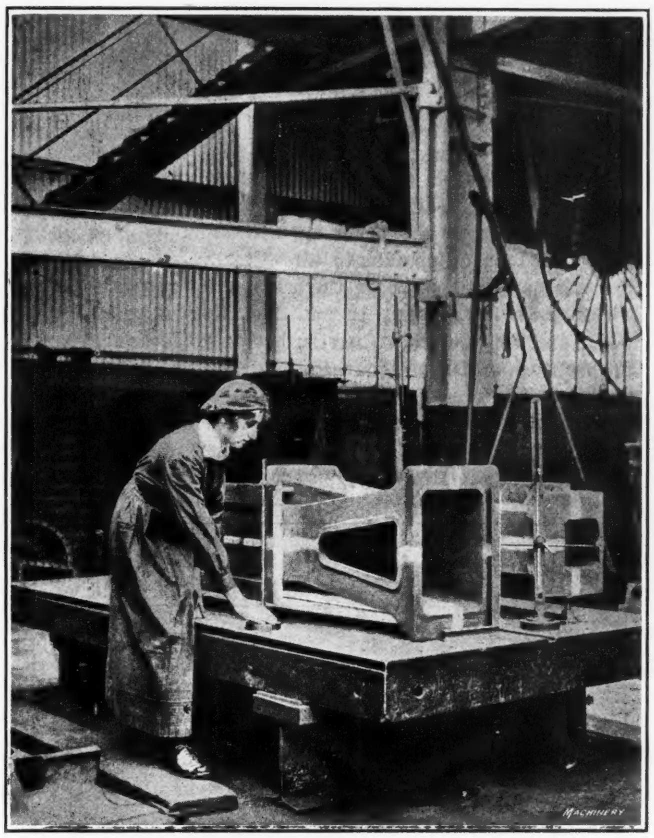


Fig. 1. Marking off Columns of Reciprocating Engine with Surface Gage

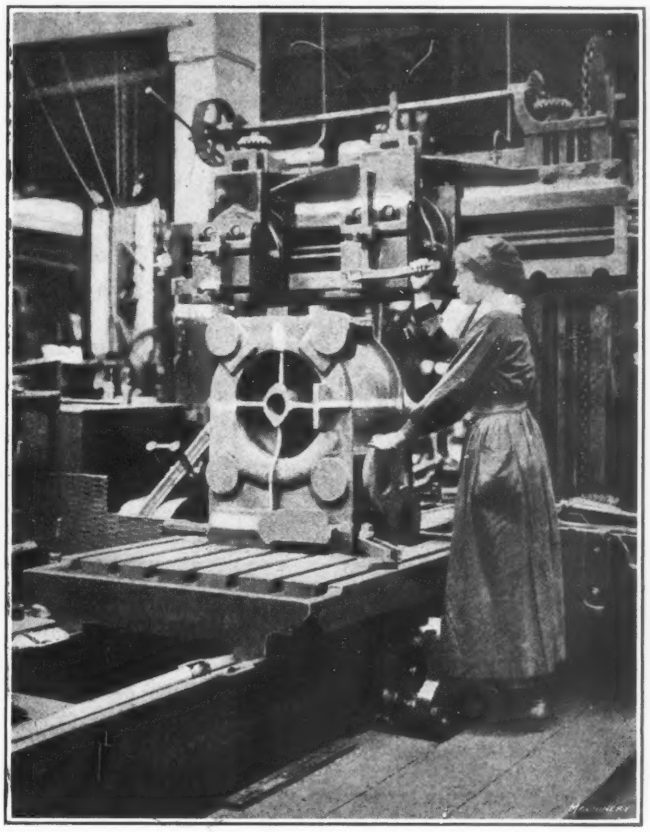


Fig. 2. Planing a Cylinder

WOMEN WAR MUNITIONS WORKERS

One of the most important influences of the European war on the industrial life of the nations involved is the awakening of the people to their own capabilities. This is particularly true in the case of women who have been called to the service of their country as truly as men on the battlefields. The response has been great, and we find today women in many branches of industry, carrying on the work as efficiently, perhaps, as the men. In view of the fact that the women of the United States will probably be called upon to fill the places in many industries of men who are engaged at the front, it is of interest to note what has been done by the women in England. *Engineering*, of London, shows some views of the work being carried on by women in the machine shops, reproduced herewith. It is pointed out that the work of the women in munitions manufacture is not confined to repetitive work, which resolves itself merely into tending a machine that has been set up correctly by men, but they are employed on jobs that demand close attention and a high degree of intelligence. Fig. 1 shows a woman engaged in marking out the columns of a reciprocating engine with a surface gage. The woman in Fig. 2 is setting the tool for planing a cylinder. In Fig. 3 the top of an aero-engine cylinder is being milled on a Becker vertical milling machine. The limit on this work is 0.05 millimeter, and the tool, as well as the work, is set up by the women. Fig. 4 shows a large lathe job—turning the jacket forging for a 60-pound howitzer. It may be mentioned that women are also employed in the foundry on such work as core making, where considerable strength is required for lifting heavy weights; in aeroplane factories, making the various parts of the aeroplanes; and on such precise work as dividing pearl dials for prismatic compasses.

* * *

Notwithstanding its lack of raw materials, Japan has developed its manufactures until there are now in the country 16,000 factories, using 1,125,000 aggregate horsepower and employing 1,500,000 hands, against 4000 factories that used 120,000 horsepower ten years ago. Among other raw materials, these factories import 80,000 tons of old iron annually.

Fig. 3. Milling Top of Aero-engine Cylinder

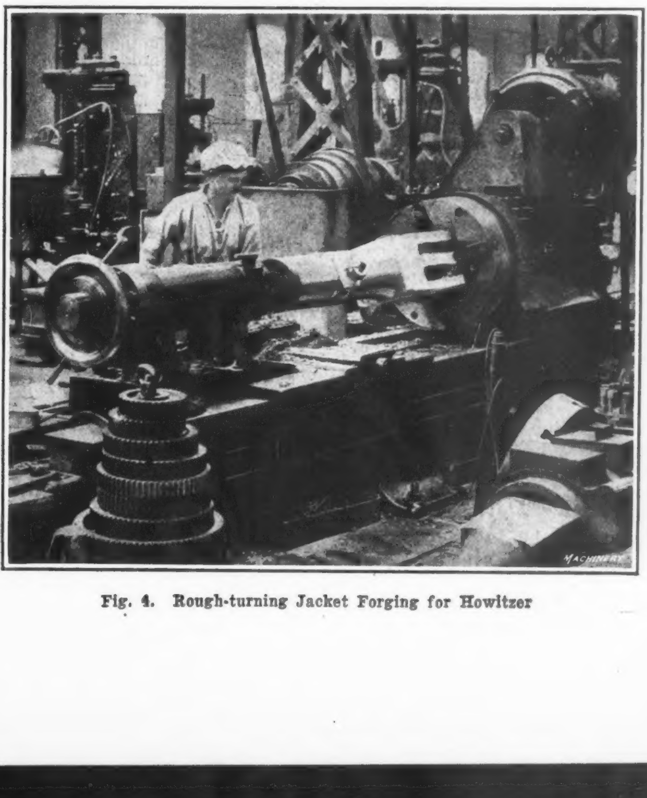


Fig. 4. Rough-turning Jacket Forging for Howitzer

WIRE STRAIGHTENERS

PRINCIPLE OF ACTION AND CONSTRUCTION OF MACHINES

BY FRANK H. MAYOH[1]

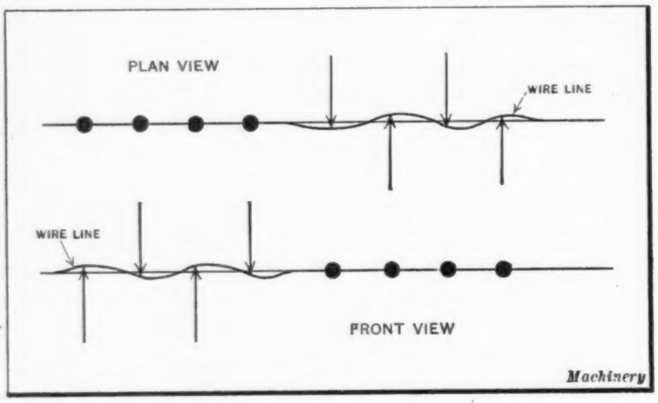


Fig. 1. Diagram of Bending Action in straightening Wire

MANY simple articles require considerable care in their manufacture; for instance, in making the ordinary wire articles that are in everyday use, it is necessary to straighten the wire before bending it into shape. The purpose of a wire straightener is to take out the natural curl of the wire, as it comes from the reel, and any kinks or bends it may contain. This is frequently accomplished by passing the wire through rolls or pins that are staggered, as indicated by the arrows in Fig. 1. The pins or rolls overcome the elastic

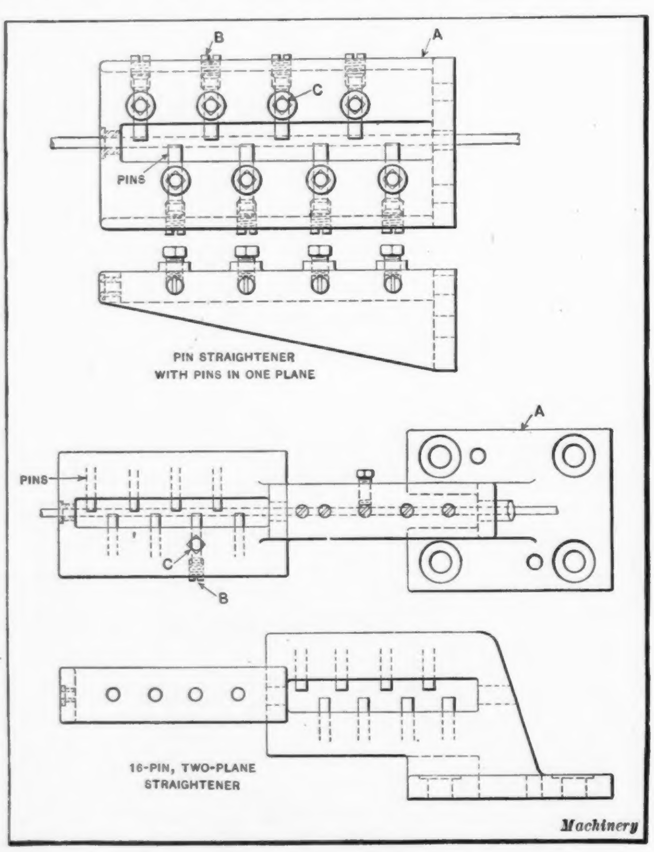


Fig. 2. Wire Straighteners of the Pin Type

tendency of the wire by bending it in opposite directions; these bends become less pronounced as the wire passes through the straightener, until it emerges practically straight. Other machines perform this function by the use of an arbor carrying a number of dies. If the wire had kinks in it when it went into the forming machine, unsightly work would be produced, wire would be wasted, and the working of the machine would be interfered with by the wires catching in the feed slide or forming tools.

The design of a straightener depends on the material being formed, the length of the wire article, and the degree of straightness necessary. Whether it is of the pin, roll, rotary, oscillating die, or any other type, it must not mar the wire and should be adjustable to allow for varying conditions of the wire and the wear of the rolls, pins, dies, etc., through which the wire passes. In addition, it must not stretch the wire; and while a slight tension between the straightener and the feeding unit of the machine is desirable, this must not be great enough to cause slipping of the feeding rolls, as it might cause part of the work to be cut off in short lengths.

Fig. 2 shows simple pin straighteners that consist of a bracket *A* into which the pins are placed, adjusting screws *B*

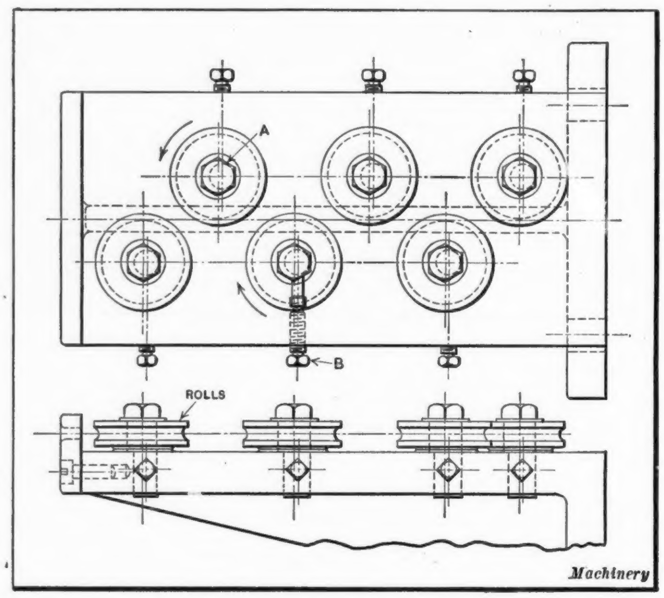


Fig. 3. Six-roll Eccentric-stud Wire Straightener

for the pins, and locking screws *C*. The upper view shows a straightener having pins in one plane only, and the lower view shows pins arranged at right angles to each other, or in two planes. A straightener having six rolls in one plane is shown in Fig. 3. These rolls are mounted on eccentric studs *A*, which are locked by screws *B* when the rolls are set against the wire with the required tension. This is accomplished by the eccentric throw of the studs as they are turned in the direction of the arrow.

The construction of these straighteners depends on the size of the wire and the degree of straightness required. Large wire requires fewer points of contact, or rolls, for straightening than the smaller sizes. The number of rolls is frequently eight for large wire and twelve for the smaller sizes, although there is no particular disadvantage in using twelve or more rolls for all sizes where one machine must be used for a number of sizes of wire. In roll straighteners, much of the friction of pin straighteners is eliminated, so that roll straighteners will handle large wire, whereas pin straighteners can

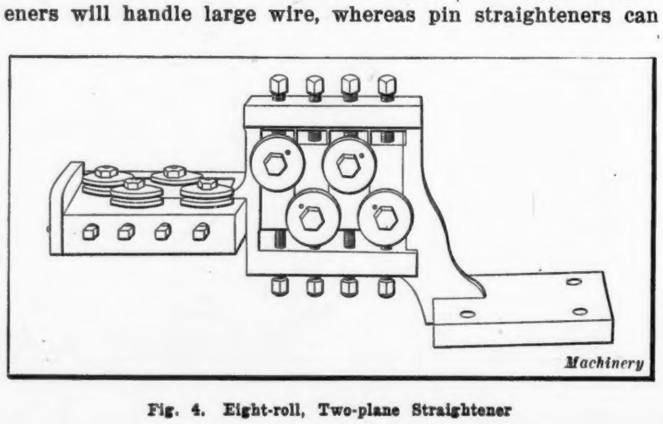


Fig. 4. Eight-roll, Two-plane Straightener

[1]Address: 87 Samuel Ave., Pawtucket, R. I.

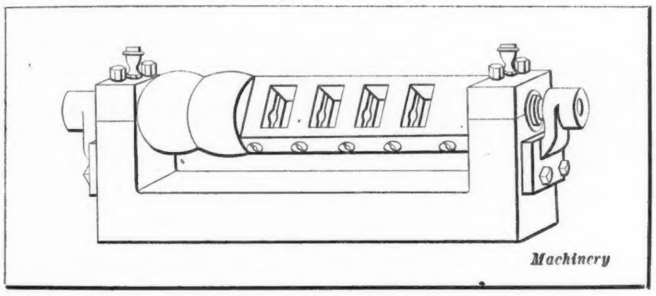


Fig. 5. Five-die Rotary Straightener

be used only with wire of small diameter. Fig. 4 shows an eight-roll straightener in which the rolls are mounted in two planes, at right angles to each other. These rolls are mounted in a bracket, the foot of which is arranged for central, vertical or horizontal attachment to the machine or for mounting on an independent base. The rolls are mounted in independent blocks or slides, and each roll may be adjusted separately.

A type of straightener that will do more accurate work than the foregoing is shown in Fig. 5. It is known as a rotary die straightener because it revolves as the wire passes through it, and the actual straightening is done by dies of a material that is tough, but softer than the wire operated upon, such as

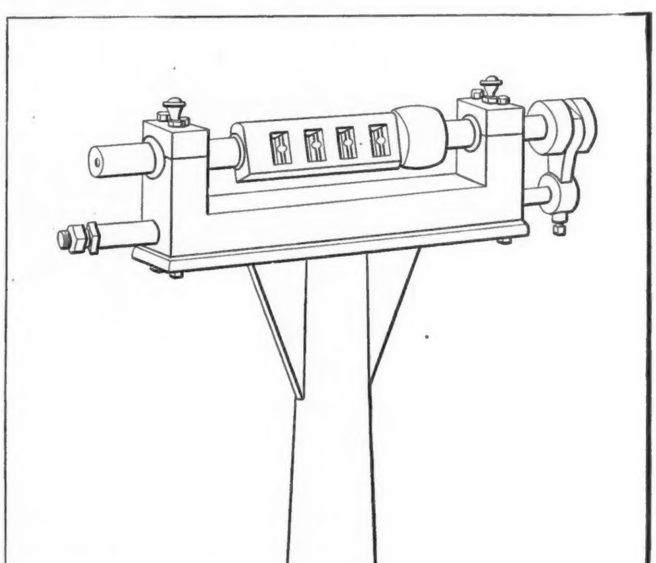


Fig. 6. Rotary-oscillating Wire Straightener of Die Type

babbitt, white iron and gun metal. The construction of the rotary straightening arbors is shown in Fig. 7; this is a sectional view through the center and shows the means of adjusting the dies to bring them in contact with the wire. A rotary straightener, however, cannot be used on formed wire, as the dies, in revolving, will come in contact only with the large parts of the wire; it is customary, therefore, to use a roll straightener on this work.

In Fig. 6 is shown a five-die straightening arbor mounted on a base. In addition to its rotary motion, this arbor is

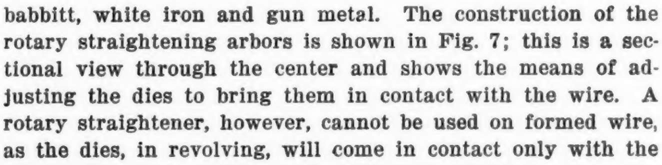


Fig. 7. Section through Rotary Straightening Arbor

caused to oscillate back and forth over the wire. This type of straightener is known as the "rotary-oscillating die straightener." The rotary straighteners are usually revolved by a belt passing over a pulley, while the oscillating motion is obtained by various means, such as a cam and lever, a face cam on the arbor, a plunger with spring return, etc. Any of the roll straighteners shown may be arranged as rotary-oscillating straighteners.

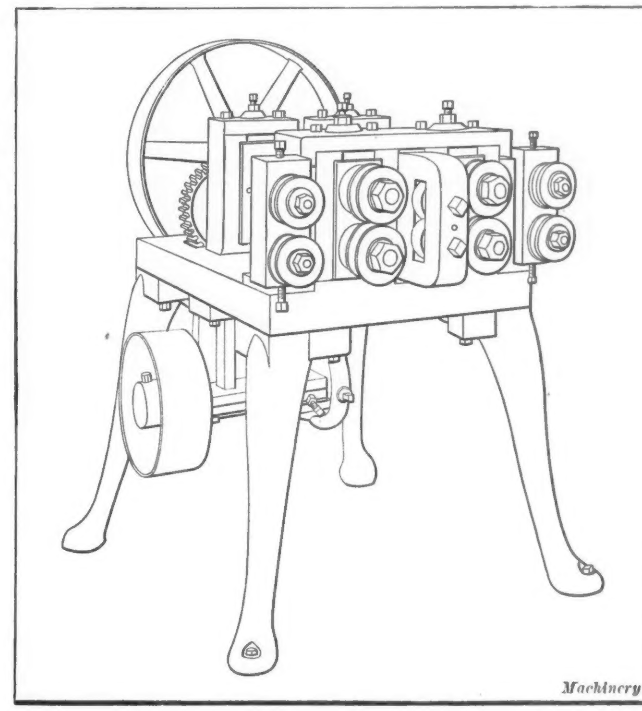


Fig. 8. Straightener for Hot-rolled Bars

As the straightening of wire is a drawing process and is attended with considerable friction, some provision must be made for lubricating the wire. This is accomplished by passing it through a box containing oily waste, as part of the machine, or by the operator hanging a piece of waste over the wire in such a manner that it will not be drawn into the machine; in addition, the rolls and bearings of the straightener should be well oiled. The rolls on a wire straightener

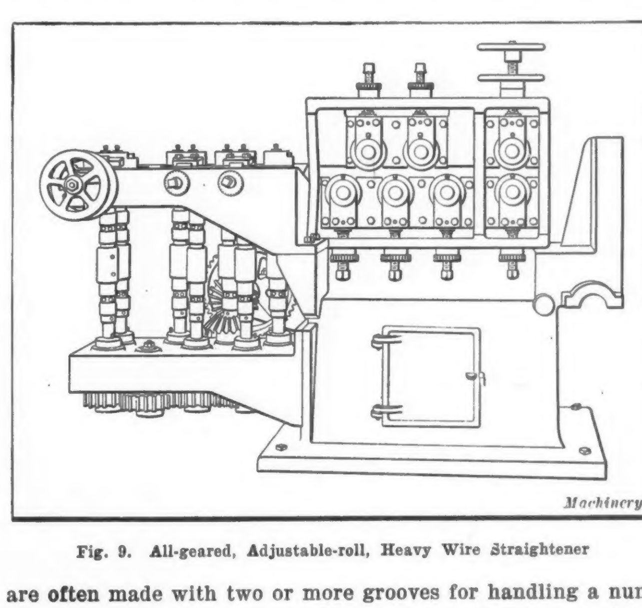


Fig. 9. All-geared, Adjustable-roll, Heavy Wire Straightener

are often made with two or more grooves for handling a number of sizes of wire; these are known as "multi-groove straighteners."

Four types of straighteners embodied as complete units are illustrated in Fig. 10. These are mounted on pedestals and are: a roll straightener with roll feed, a rotary die straightener with roll feed, a rotary die straightener with roll feed and cutting-off attachment for short lengths, and a rotary straightener with a guard, or protecting hood, in place. In Fig. 8 is

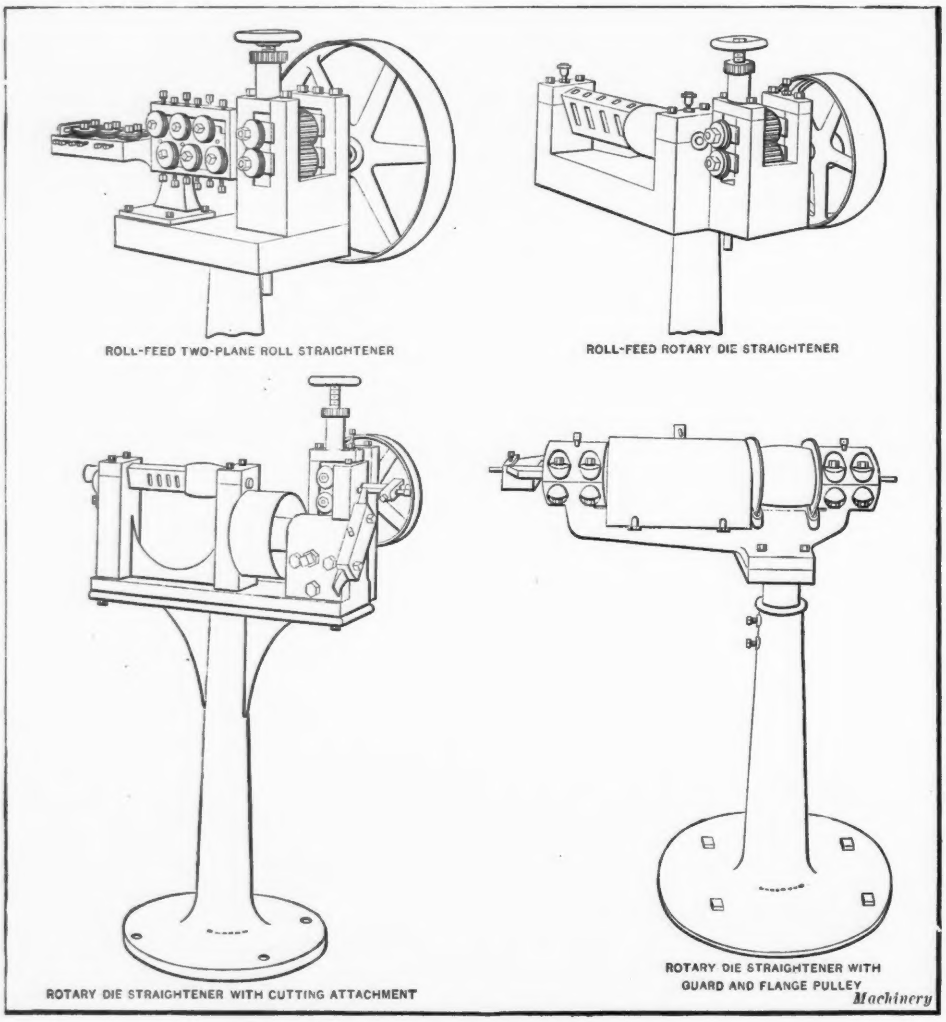


Fig. 10. Four Types of Plain Belt-driven Straighteners

shown a straightener for handling hot-rolled bars. It will be noticed that this machine is heavily constructed and has a roll feed. Its purpose is to straighten the bars and remove the surplus scale preparatory to being operated on in the screw machine.

Another type of wire straightener is illustrated in Fig. 9. This is an all-geared machine with roll feed; its operation is obvious from the illustration. The three lower rolls are fixed, while the two upper rolls are mounted in an equalizing block and are brought into contact with the wire by means of adjusting screws. The rolls in the other plane are, of course, adjusted in the same manner. These machines are of heavy, rigid construction. In the machine shown, the rolls have an independent adjustment in both vertical and horizontal planes. The rolls are driven by the gears, universal joints permitting a large range of adjustment without interfering with the gearing.

The machine illustrated in Fig. 11 is for straightening and cutting off ¾-inch wire of various lengths. This machine has a roll straightener *A* for rough-straightening the wire, while the finish-straightening is done by rotary wire straightener *B*. The wire next passes through two feed rolls *C*, along a grooved guide bar until it strikes a gage, when it is cut off.

* * *

Celluloid will become as soft as jelly if left for a few hours in an ether bath. If dried in a mold, it will retain the shape of the mold.

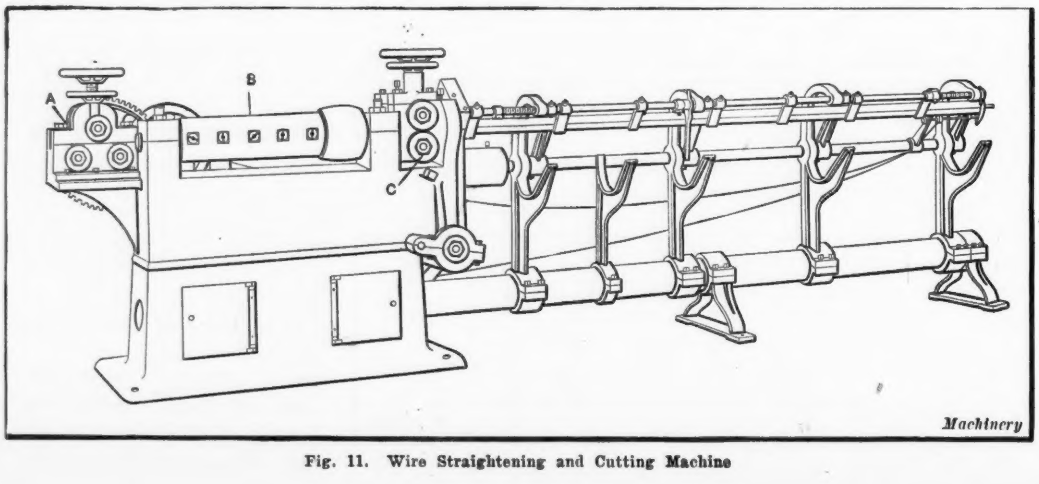


Fig. 11. Wire Straightening and Cutting Machine

STANDARDIZATION OF SCREW THREADS

The Engineering Standards Committee of Great Britain, with the active cooperation of the Ministry of Munitions, is making an investigation with a view to simplifying the manufacture and gaging of the Whitworth form of screw threads. It has been urged before the committee that the difficulty experienced in the production of interchangeable Whitworth screw threads is largely due to the fact that a fit must be obtained on all the five elements of the screw thread—namely, the angle, the outside diameter, the pitch or angle diameter, the root diameter, and the lead—and that by suitable modifications in the form of the thread, the necessity of close adherence to some of these dimensions could be avoided without injuring the character or value of the screw thread for its service. The modifications would increase the rate of production and simplify the methods of gaging and inspecting the finished product.

For the purpose of obtaining the views of manufacturers and gagemakers as to whether any modifications in the form of the Whitworth thread are desirable, the subcommittee on screw threads of the Engineering Standards Committee has drawn up a list of questions which are submitted to firms and individuals likely to have an opinion upon the subject. The most important of these questions relates to whether any alteration in the present form of the Whitworth thread is desirable; whether the revised form, if adopted, should be interchangeable with the existing Whitworth thread; whether clearance should be made at the top and roots of the thread; and whether it would be advisable to change the existing angles of Whitworth and British Association screw threads to 60 degrees, as a step toward securing interchangeability with the United States standard or the International standard thread.

Anyone especially interested in this matter, who would like to get the published material issued by the Engineering Standards Committee bearing upon this subject, can obtain it upon application to the secretary of the Engineering Standards Committee, 28 Victoria St., Westminster, London, S.W.-1, England.

* * *

If you think you can't, you won't.

UNIVERSAL AMPLIFYING GAGE

This is a universal gage adapted for testing work produced in both the tool-room and manufacturing departments of a factory. Two types of machines are built, which are illustrated in Figs. 1 and 2; and an idea of the range of work that can be tested will be obtained from Figs. 4 to 6, which show typical examples of gaging operations. Not only does this machine provide an accurate method of gaging—the limit of accuracy is 0.0001 inch by a direct-reading dial indicator—but being universal in its scope, the machine represents an investment rather than an item of expense, as in the case of special gages which are only suitable for one particular line of work.

Manufacturers who are engaged in the production of interchangeable parts and other work where it is necessary to maintain close dimension limits are always anxious to equip their shops with the best tools. First cost is a secondary consideration, the point of prime importance being to obtain tools that are capable of reducing the cost of manufacture to a minimum. For use in tool-rooms for gaging accurate tool and die work, and also for testing the accuracy of production work, the North Side Tool Works, 267 Air St., Dayton, Ohio, have recently developed a machine known as a universal amplifying gage, which is illustrated and described herewith. The design has been worked out with the view of simplifying the gaging system in a factory. It is rigidly built, and all parts subject to wear are made of hardened steel to insure durability. This machine will take the place of 75 per cent of the snap gages in a shop and is capable of measuring to 0.0001 inch. Work up to 5½ inches may be taken on the plate, and work up to 8 inches may be taken between centers. The arrangement of the machine is such that work may be gaged with extreme rapidity. An important advantage of this method of gaging is that there is no guesswork, measurements being taken by a direct-reading indicator, so that when a piece is over or under the required dimension, the exact amount of error is indicated on the dial of the gage.

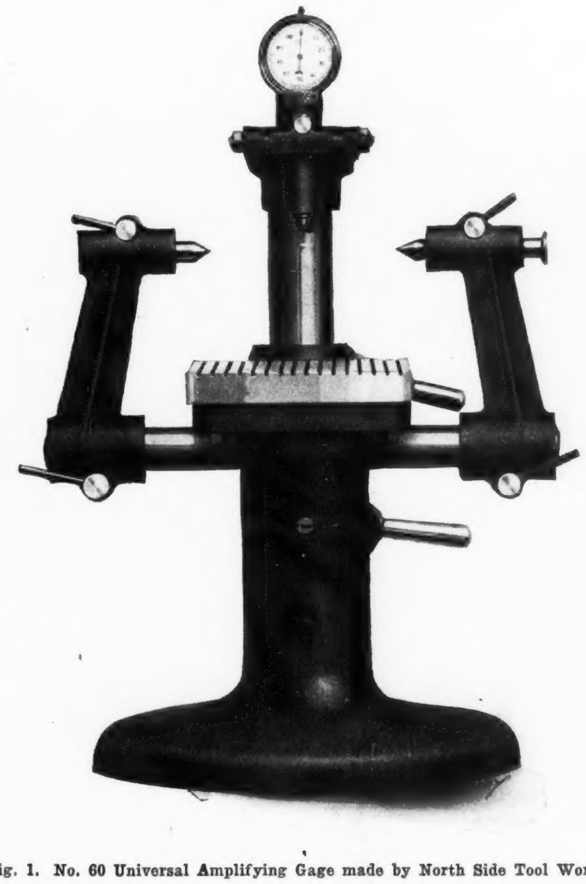


Fig. 1. No. 60 Universal Amplifying Gage made by North Side Tool Works

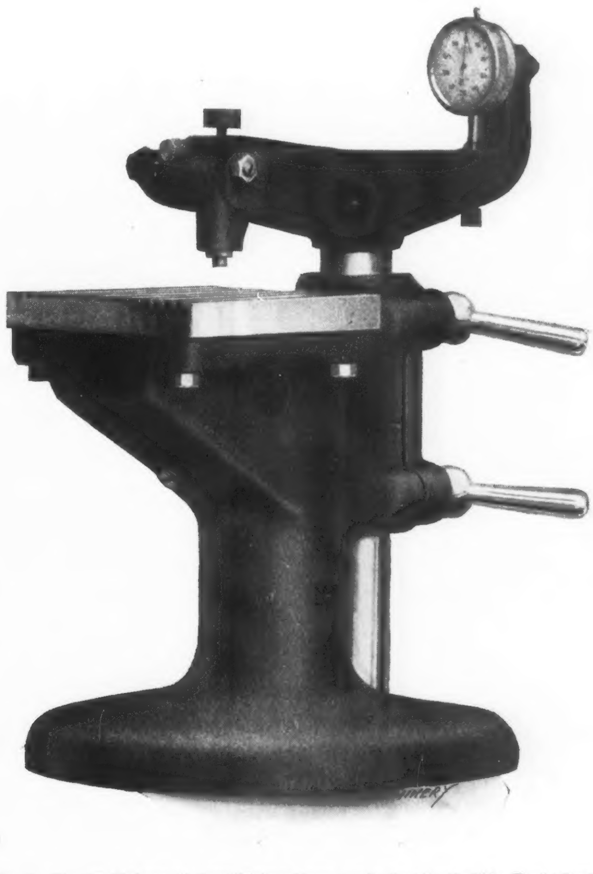


Fig. 2. No. 67 Universal Amplifying Gage made by North Side Tool Works

Fig. 3 shows the method of testing work on centers, and it will be seen that this illustration shows an arbor which is being tried out to ascertain whether it is fit for use in the production of accurate work. This method of testing can be applied to all work finished on centers, or more particularly to work produced on grinding machines, both in the tool-room and in manufacturing departments. A conscientious workman will take time to try out an arbor in the lathe, but in so doing he only has a gage capable of showing results to 0.001 inch.

For surface work, the universal amplifying gage has a hardened plate 5 by 6 inches in size; and when so desired this plate can be removed and a special fixture attached to the bed of the machine either temporarily or as a permanent feature. This arrangement is shown in Fig. 4, which clearly illustrates the method of testing work of this kind. Fig. 5 shows the method of testing work that has a shoulder. This is done by bringing the shoulder into contact with the edge of the table and gaging the diameter of the work by rolling it under the contact point of the dial test indicator. In Fig. 6 the rear center has been removed, and a plug substituted and clamped in place with the same screw that is used to tighten the center. An arrangement of this kind is extremely useful for testing the concentricity of such work as gears, etc.

It will be evident from what has already been said that this is strictly a universal gage, and that it can be used on a great variety of work. The price of the machine is not prohibitive, and as it can be used continually on different classes of work instead of being put in the store-room as soon as a job is over, it will be evident that this method of gaging is far more eco-

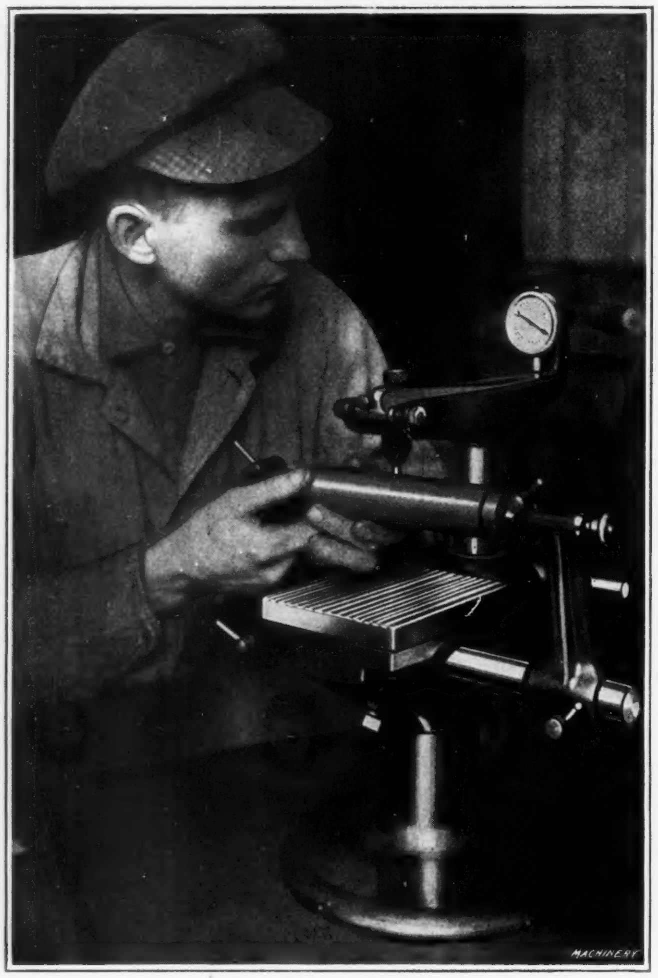


Fig. 3. Method of testing Accuracy of Work held on Centers

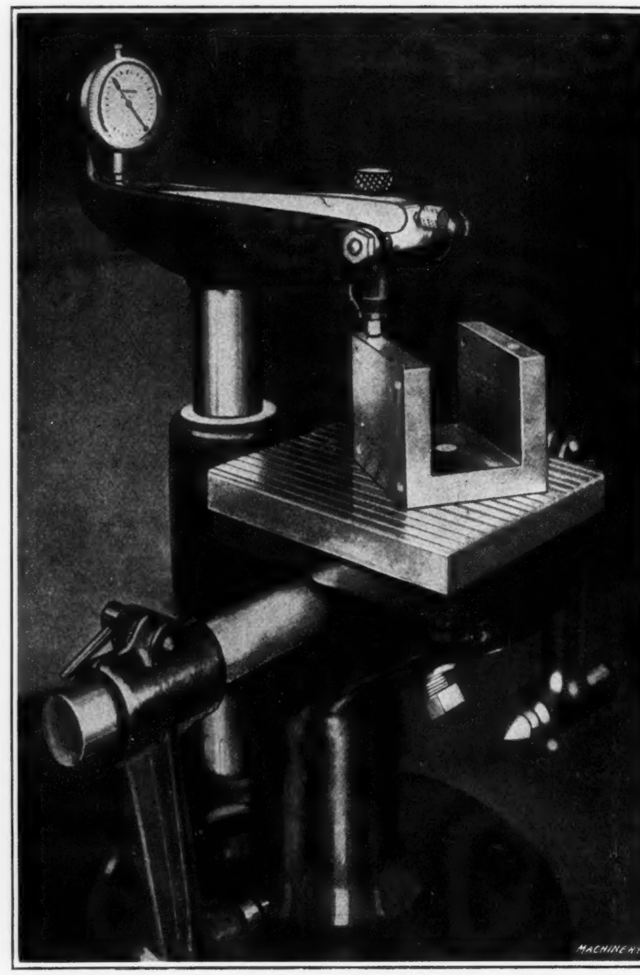


Fig. 4. Procedure followed in testing Accuracy of Surface Work

nomical than to invest in special snap gages, etc. Reference has already been made to the fact that the gage is made to read to 0.0001 inch, and the graduations on the dial are 1/16 inch apart, so that there is no difficulty about making accurate readings. The machine is made in two styles, known as Nos. 60 and 67, which are illustrated in Figs. 1 and 2, respectively; the No. 60 gage weighs 48 pounds, and the No. 67 gage weighs 54 pounds.

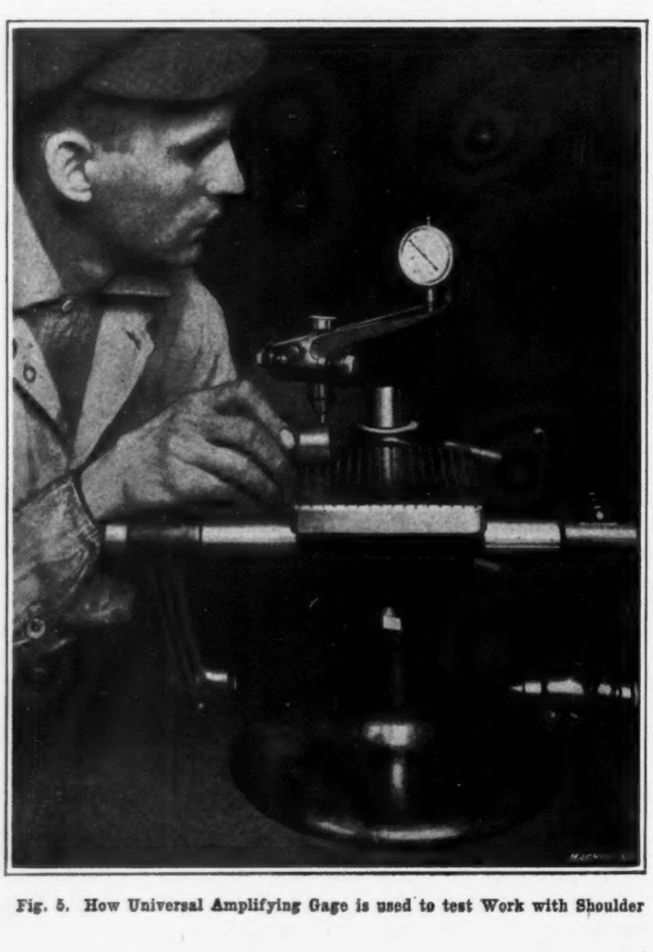


Fig. 5. How Universal Amplifying Gage is used to test Work with Shoulder

Fig. 6. Rear Center replaced by Plug to support Work to be tested

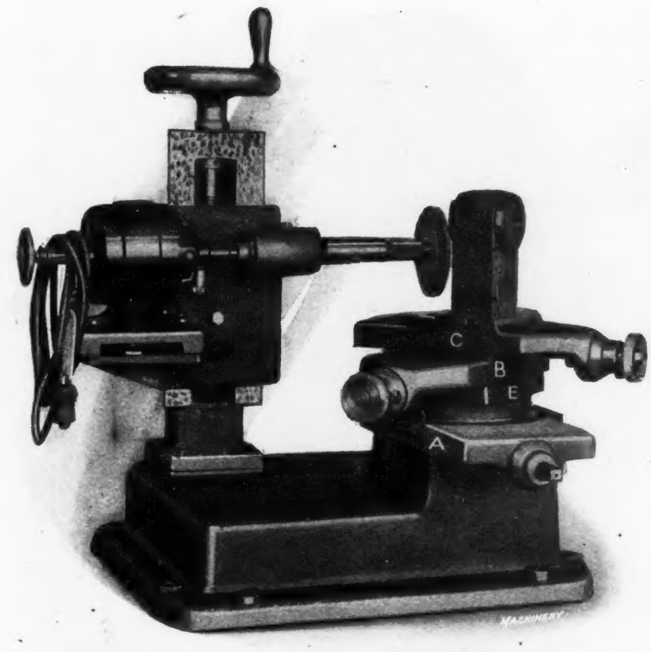


Fig. 1. Profile Grinder built by Cleveland Milling Machine Co.

CLEVELAND PROFILE GRINDER

For use in grinding round corners on milling cutters and for similar classes of work, the Cleveland Milling Machine Co., 18,511 Euclid Ave., Cleveland, Ohio, has recently developed a profile grinder, which is illustrated and described herewith. This machine has a capacity for handling small sizes of cutters, its range being for work all the way from zero to 12 inches in diameter; and round corners may be ground either concave or convex with radii ranging from 1/8 to 3 inches. The Cleveland Milling Machine Co. manufactures a large number of cutters, and for use in this work it requires a profile grinder. To meet this requirement, it became necessary to develop the machine which forms the subject of this article, and the results obtained were so satisfactory that it was decided to place the grinder on the market.

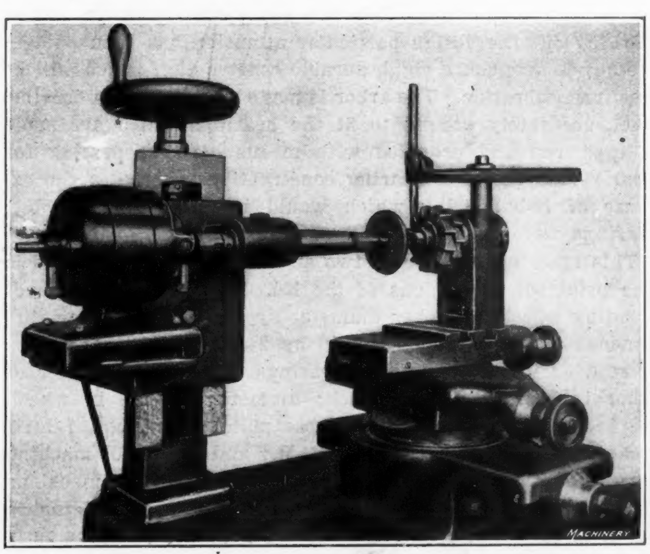


Fig. 2. Close View of Wheel and Work on Machine shown in Fig. 1

Direct connection is made between the wheel-carrying spindle and the motor shaft, and the grinder is equipped with a wheel 4 inches in diameter by 1/4 inch face width. A bracket carrying the motor and wheel-spindle is mounted on a vertical housing and adjusted by a screw provided with a micrometer dial. Arbors for holding the work are held in a sleeve that revolves freely in the work-holding posts. Four posts are furnished with No. 9 and No. 7 Brown & Sharpe tapers, one with a 1/2-inch straight hole and one flat block for holding flat tools in order to cover all the classes of work for which the machine is adapted. It will be seen that these posts fit into three T-slots in the upper compound slide *C*, Fig. 1, thus providing for handling a wide range of work. The upper slides *B* and *C* are used to bring the work into the proper sweep across the face of the wheel, and these, in turn, are mounted on a swivel block *E* which is pivoted onto the bottom slide *A*.

A gage is furnished to set the work in the proper relation to the wheel, and when the bottom slide *A* is set for a given radius, the machine will always grind that radius regardless of the continued adjustment of the two upper slides *B* and *C*. A convenient tooth rest is furnished with sufficient range to cover all work within the capacity of the machine. All screws are provided with micrometer dials graduated for adjustments to 0.001 inch, the dials being graduated from zero to 100 for a 10-pitch screw. All slides are accurately scraped and provided with gibs for taking up wear. In addition to its application in grinding round corners on milling cutters, this machine is used to grind concave and convex cutters, cutters for fluting drills, cutters that are irregular in contour but which have a number of true curves, form tools for screw machines, and for rounding the corners of tools used on lathes, planers, shapers, etc. Some of this work is shown in Fig. 3.

The regular equipment furnished includes a type D "Dumore" universal motor with 10 feet of wire and a plug to fit any lamp socket on a 110-volt direct- or alternating-current circuit; one grinding wheel 4 inches in diameter by 1/4 inch face width; one work-arbor, 1 inch in diameter; one tooth rest; four work-posts; one gage for radius setting; one 7/8-inch work-arbor, and the necessary wrenches for making all adjustments. The floor space occupied by this machine is 30 by 24 inches, and it has a net weight of 217 pounds.

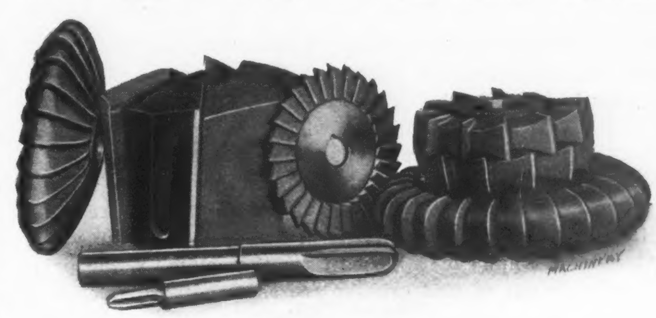
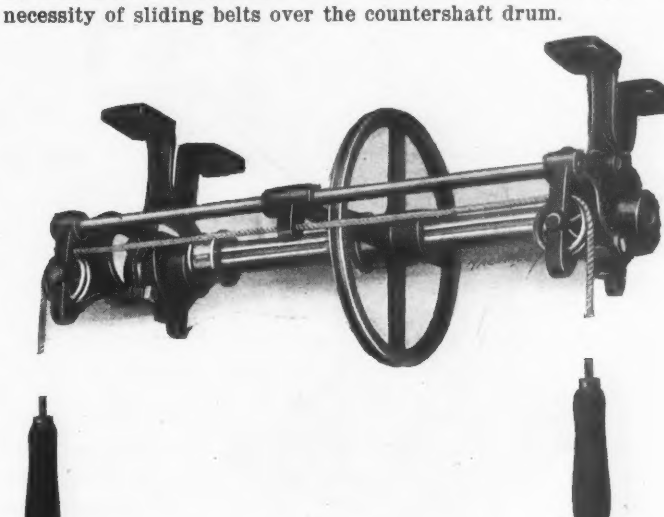


Fig. 3. Examples of Work done by Cleveland Milling Machine Co.'s Profile Grinder

DALTON GRINDER COUNTERSHAFT

A countershaft especially designed for driving small lathes of all makes using internal or external grinding attachments, has recently been placed on the market by the Dalton Machine Co., Inc., 1911-1915 Park Ave., New York City. In designing this equipment provision has been made for having the driving pulley travel the entire length of the shaft, so that the belt is always in line with the pulley of the grinding attachment. By this method much time can be saved through avoiding the necessity of sliding belts over the countershaft drum.


Dalton Machine Co.'s Countershaft for driving Small Lathes with Grinding Attachments

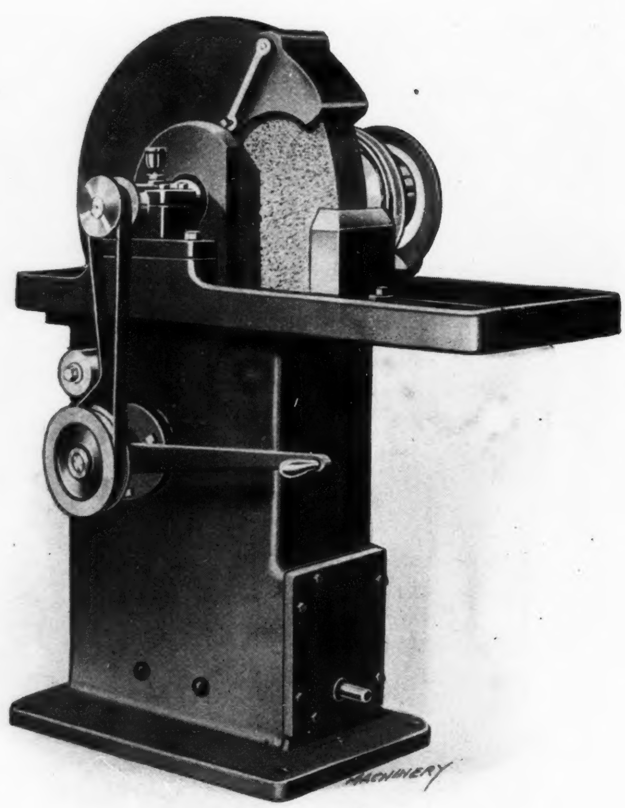
The pulley referred to is of the grooved type and is 9 inches in diameter; it has a travel of 14 inches and is keyed to the shaft. Travel of the pulley is accomplished by pulling on handles attached to a rope, which is of sufficient length to be easily reached by the operator. This rope is attached to a cast-iron arm, which is forked at one end and fitted to a channel in the pulley hub; the other end travels on a rod which is an integral part of the countershaft. The hangers are universally adjustable, so that they can be mounted on the wall or ceiling; and all bearings are of liberal size and provided with ring-oilers.

MANHATTAN SURFACE GRINDER

One of the latest additions to the line of machinery built by the Manhattan Machine & Tool Works, 42-50 Market Ave., N. W., Grand Rapids, Mich., is a No. 12 surface grinder which is illustrated and described herewith. This is a heavy-duty grinder and has been carefully designed in order to eliminate vibration. The grinding wheel is so arranged that it may be used for grinding the table of the machine in order to insure having the table at exact right angles to the spindle. A grinding wheel 12 inches in diameter by 1 inch face width is used on this machine, and the spindle has bearings 1½ inch in diameter which run in split brass boxes. These bearings are of the self-oiling type, lubricant being drawn from a large reservoir. Any type of dividing head can be used on this grinder.

The knee is raised or lowered by a screw, and the handwheel is furnished with a graduated dial reading to 0.001 inch having a lock-nut for holding it in any desired position. The cross-head has a screw and handwheel, this wheel also being furnished with a graduated dial. The table is operated by a rack and spiral gear and is furnished with two adjustable stops. Provision may be made for surfacing the entire table of the grinder with its own wheel, as mentioned, the wheel having an overhang of 8 inches from the column. The principal dimensions of this grinder are as follows: diameter of spindle pulley, 5 inches; face width of spindle pulley, 3½ inches; distance from center of spindle to floor, 48 inches; over-all length of table, 48 inches; size of working surface of table, 36 by 7½ inches; size of T-slots in table, ⅝ inch; maximum distance from wheel to table, 13½ inches; and net weight of machine, 860 pounds.

No. 12 Surface Grinder built by Manhattan Machine & Tool Works



Wet Tool Grinder built by Noble & Westbrook Mfg. Co.

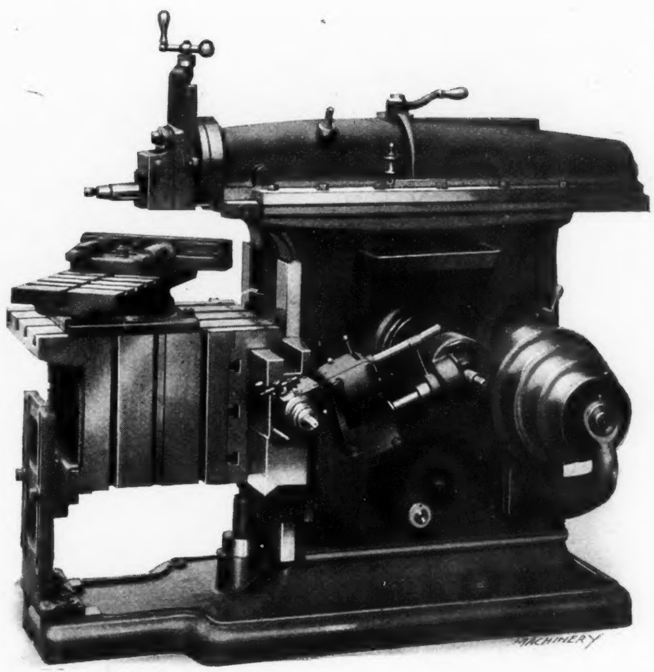
NOBLE & WESTBROOK WET TOOL GRINDER

The Noble & Westbrook Mfg. Co., Hartford, Conn., is now building the wet tool grinder shown in the accompanying illustration. An important feature of the design of this machine is the water carrier which is arranged with a chain in such a way that it will not flood or throw water on the man operating the machine. This is a heavy-duty machine, and in working out the design particular attention has been paid to the development of a rigid, durable construction which will be free from vibration. The arbor is made of high-carbon crucible steel, accurately ground to fit the bearings which are made of cast iron and provided with means of compensating for wear. This cast-iron bearing construction eliminates the expense of re-babbitting which would be involved if babbitt bearings were used.

This machine is made in two sizes known as Nos. 4 and 5. The principal dimensions of the No. 4 machine are: size of grinding wheel, 20 inches diameter by 2½ inches face width; dimensions of machine base, 16 by 24 inches; height to top of rest, 39 inches; length of bearings, 6 inches; diameter of arbor in bearings, 1 9/16 inch; diameter of hole in wheel, 2½ inches; size of tight and loose pulleys on arbor, 7 by 3 inches; speed of wheel, 950 R. P. M.; and weight of machine crated for shipment, 700 pounds. The principal dimensions of the No. 5 machine are: size of grinding wheel, 24 inches diameter by 3 inches face width; dimensions of machine base, 18 by 28 inches; height to top of rest, 38 inches; length of bearings, 7 inches; diameter of arbor in bearings, 1 11/16 inch; diameter of hole through wheel, 2½ inches; size of tight and loose pulleys on arbor, 7 by 4 inches; speed of wheel, 850 R.P.M.; and weight of machine, crated, 850 pounds.

QUEEN CITY SHAPER

In a new 24-inch back-geared crank shaper which has recently been placed on the market by the Queen City Machine Tool Co., Cincinnati, Ohio, it is claimed that work can be produced within 0.001 inch of parallel for the full 24-inch stroke, without having to take any steps to overcome inaccuracies in the machine. All gearing is of the cut helical type which experiments have shown to be well suited for this particular class of service, as it enables the machine to do smooth



Queen City 24-inch Back-geared Crank Shaper

work, entirely free from chatter marks or gear waves. In working out the design, the machine has been made exceptionally low in order to bring all operating handles within easy reach of the operator. Feed-screws are furnished with micrometer adjustments and all swivels are graduated. The length of stroke can be quickly changed and positively locked while the ram is either in motion or at rest. Sixteen changes of feed are instantly obtainable, and these changes may be made without danger of accidents. There are eight available cutting speeds for every change of stroke and these are arranged in geometrical progression as follows: 6.4, 9.3, 13.5, 20, 30, 44, 63, and 92 strokes per minute at 290 revolutions per minute; but with the all helical drive much higher speeds can be used without excessive noise or other indications of trouble. Attention is called to the table support; the table moves automatically up and down with the rail and is self-oiling.

The principal dimensions of this machine are as follows: automatic cross travel, 27 inches; vertical adjustment of table, 15 inches; distance from ram to table, 2 to 17 inches; size of tool used, 1¾ by ¾ inch; length of table and saddle, 24½ inches; width of table and saddle, 17½ inches; height of table and saddle, 15 inches; capacity for keyseating, up to 3½ inches; size of regular vise jaws, 15½ by 2¾ inches; maximum opening of vise, 14 inches; number of changes of speed for ram, 8; slow back-gear ratio, 5½ to 1; and regular back-gear ratio, 26 to 1.

BRADFORD-ACKERMANN LEAD BURNING APPARATUS

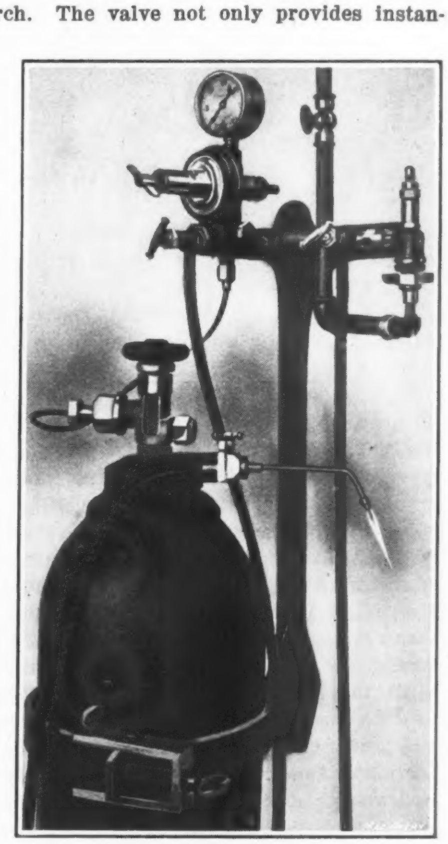
For use in lead burning, hard tempering, etc., the Bradford-Ackermann Corporation, Forty-second St., Bldg., New York City, has recently placed on the market the "Astra" oxy-illuminating gas apparatus, which can be used to advantage in storage battery service stations, garages, and other places where lead burning and similar operations have to be performed. By means of special appliances made by this company, the scope of the apparatus can be broadened to include auto cylinder decarbonizing, oxy-acetylene welding and cutting, and other operations. This equipment is manufactured by Ashton, Laird & Co., of New York City, and sold by the Bradford-Ackermann Corporation.

Lead burning is an operation that calls for specially designed equipment, and this "Astra" oxy-illuminating gas outfit has been particularly developed to meet the requirements of this service. In addition to lead burning, it may be employed for welding brass, aluminum, bronze, and other metals of similar fusing temperatures. The possibility of employing artificial or natural illuminating gas drawn directly from the gas main and employed in connection with tanked oxygen, makes this process both convenient and economical. As regards cost of operation, attention is called to the fact that illuminating gas costs less than one dollar per thousand cubic feet. The apparatus is so assembled that different component parts may be added to an existing welding or decarbonizing apparatus to provide facilities for lead burning; similarly, other appliances may be added to broaden the scope of the lead burning equipment to include hard soldering, brazing, tempering, annealing, cylinder decarbonizing, and oxy-acetylene welding.

Two standard models of "Astra" oxy-illuminating gas low-pressure lead burning apparatus are available, these being known as a stationary type S. L. P. and a portable type P. L. P. The stationary type may be securely fastened to the wall by means of a bracket on which are mounted the regulating device and gage, and also a rugged clamp for the oxygen tank. From the single equipment, the system may be piped to torches at different locations where work may be done simultaneously if desired. The portable type can be easily moved to gas outlets which are conveniently located in relation to the place where the work is to be done. A working radius of 16 feet is provided and greater reach may be obtained by means of additional hose. A compact and well balanced design has practically eliminated danger of breaking the equipment while it is being moved about.

The "Astra" regulator is so designed that it insures precision of adjustment, maintenance of constant control, and accuracy of operation. There are no soldered parts, and the new feature of a one-piece non-corrosive metallic pressure seat, and carefully counterbalanced and adjustable counter springs, provide for obtaining positive operation and a high degree of durability. All parts are interchangeable. Protective devices are provided on the oxygen regulator and oxygen back-pressure release valve for the illuminating gas line, both of which operate automatically and are provided with alarm whistles to attract attention. The regulator is equipped with a detachable and interchangeable tank connection which is adaptable to any tank regardless of thread variation. A scrubber is provided in the tank connection to prevent foreign substances from entering the essential parts of the regulator. This scrubber is easily removed for cleaning.

A two-hose torch furnished with the "Astra" apparatus weighs only 6 ounces. It is said to be as convenient to operate as a single-hose torch. The valve not only provides instantaneous adjustment of oxygen as required, but it also permits the oxygen to be shut off between operations, using only the inexpensive illuminating gas as a pilot light. Five interchangeable nozzles of assorted orifice sizes are provided with the standard apparatus and give suitable flames for various classes of work. A gage is provided on the oxygen regulator to indicate the working pressure at the nozzle; and a high-pressure gage, furnished separately, can be attached to determine the amount of gas in the oxygen tank at any time.



Bradford-Ackermann Oxy-illuminating Gas Welding and Cutting Outfit

NEWTON MULTIPLE-SPINDLE MILLING MACHINE

One of the recent products of the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa., is a multiple-spindle milling machine which has two vertical spindles mounted in saddles on the cross-rail and one horizontal spindle in a saddle carried on each of the housings. The first of these machines to be built has a capacity of 66 inches between the ends of the horizontal spindles and a maximum height of 54 inches under the vertical spindles. The finished surface of the work-table is 54 inches wide and of sufficient length to mill work 30 feet long. The right-hand horizontal spindle may rotate independently of all other spindles, and the same is true of the left-hand horizontal spindle; both vertical spindles must rotate in unison and the right-hand horizontal spindle must rotate at the same time. All spindles are made of forged steel and receive their final finish by grinding. Each spindle has a tapered end bearing and a through cutter-retaining bolt. The cutters are driven by means of broad-faced keys, and the spindle driving gear teeth are cut from a bronze ring, these teeth being of the spiral or worm type according to the size of the machine on which they are used.

The worms that drive the spindles are of hardened steel, fitted with roller thrust bearings. Lubrication of the driving mechanism is obtained by having the various worms and worm-wheels contained in oil-tight boxes so that they may be kept flooded with lubricant. The spindle speeds are independent of the table feeds, and the spindles rotate in a clockwise direction unless otherwise specified. There are nine available spindle speeds ranging from 16½ to 99 revolutions per minute, or proportionately greater or less according to the material to be machined. These spindle speeds are obtained through three sliding sleeves mounted in an oil-tight gear-box on top of the machine. All speed change-gears are made of steel or bronze. The spindle sleeves are adjusted by a hand-operated rack and pinion through a worm and worm-wheel; and they can be clamped in fixed positions when so desired.

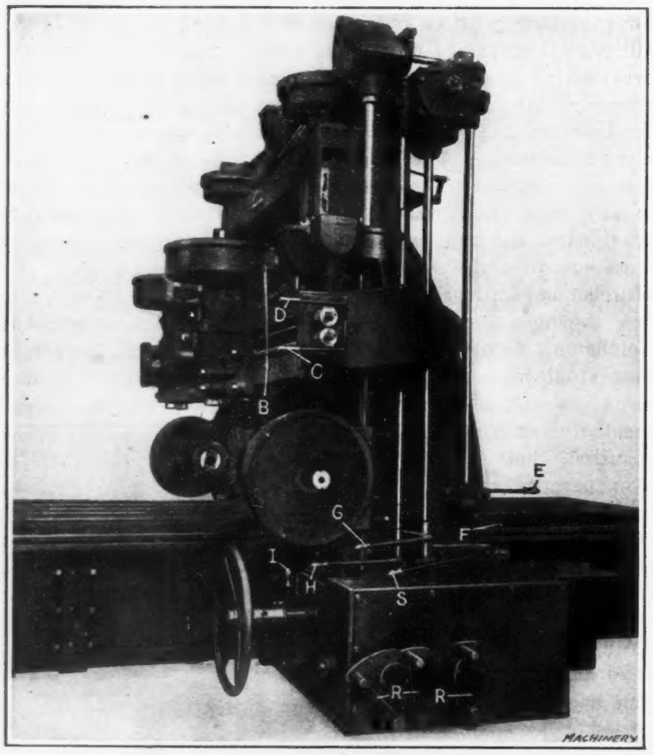


Fig. 1. Newton Planer Type Multiple-spindle Milling Machine

All the spindle saddles are made alike, whether one or two are mounted on the cross-rail. The saddles have square lock bearings and adjustments are made by taper shoes; the horizontal spindle saddles have the narrow guide construction to provide control of alignment. Both rail saddles have hand adjustment and reversing cross-feed and reversing rapid cross traverse. When two saddles are mounted on the rail, both must be fed in the same direction if they are operated in unison by power. The saddles on the uprights are counterweighted by weights mounted inside the uprights; and they have only hand vertical adjustment. Provision is made for clamping these saddles to the rail for power elevation, and also to control alignment when a horizontal cutter-arbor is used and supported from its outer ends. The vertical spindles have twelve changes of reversing cross-feed ranging from 0.178 inch to 6½ inches per minute; and reversing fast power motion of 15 feet per minute, each being controlled from the table mechanism.

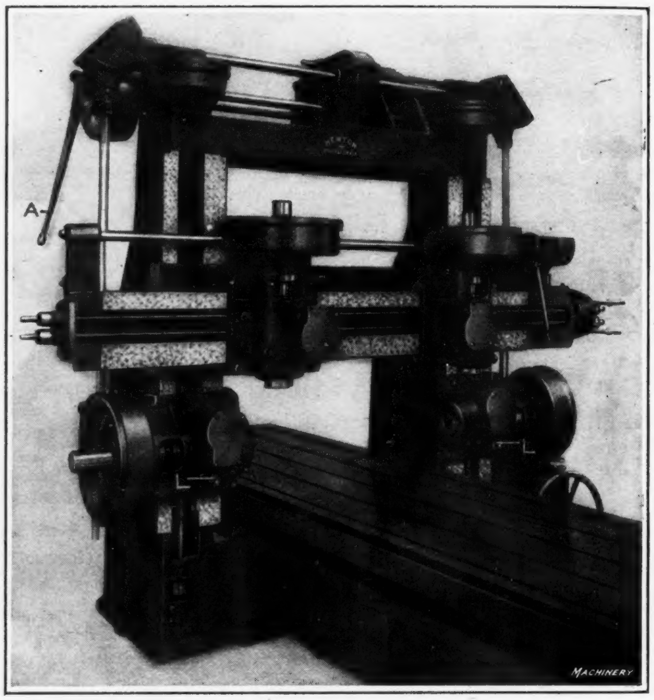


Fig. 2. Opposite Side of Newton Milling Machine shown in Fig. 1

The cross-rail has square bearings on the uprights with narrow guide construction to control alignment. The rail has reversing fast power vertical adjustment and is supported by screws with bottom tension bearings. The cross-rail is not counterweighted. A heavy box type of construction has been adopted for the work-table which is surrounded by an oil pan; this table has square bearings on the base and T-slots planed in the top from solid metal. The table feeds are independent of the spindle speeds and are twelve in number, ranging from 0.355 inch to 13 inches per minute, these rates of feed being obtainable in both directions. Changes are obtained through gearing in an oil-tight feed-box which is equipped with cut bronze or steel gears mounted on sliding sleeves that are controlled by latch levers fitted through openings in the cover. Table movement is obtained through an iron or steel angular rack and a steel or bronze worm pinion which rotates in a bath of oil. Provision is also made for obtaining hand adjustment. Rapid traverse of the table is independent of the feeds and spindle speeds, and is available in both directions at the rate of 30 feet per minute except on heavy-duty machines when the fast table traverse is reduced to 20 feet per minute.

A heavy box type of construction has been adopted for the machine base which has a solid closed top and double cross-ribs. Cheeks are furnished for the attachment of uprights. The standard design calls for a bed 1½ times the length of the

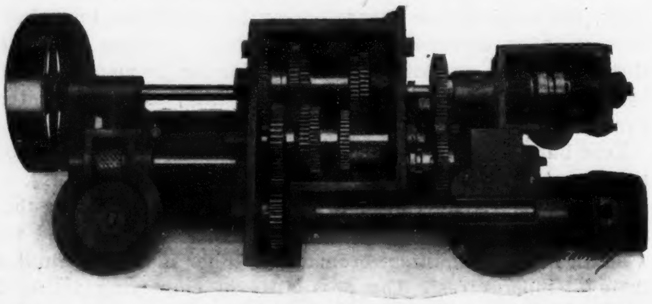


Fig. 3. Gearing in Speed Box of Newton Multiple-spindle Milling Machine

work that the machine is rated to mill. The uprights are of heavy box type construction and extend right down to the floor line; they are keyed and doweled to the base which has a broad faced key cast integral with the base to control vertical alignment. The drive is through a single pulley, which is suitable for use in connection with a countershaft speed of 495 revolutions per minute.

A feature of the machine is centralized control of all parts of the mechanism. The cross-rail gibs are scraped to a running fit when bolted tight and therefore require no adjustment in each setting in accordance with planer practice. This permits the mechanic to remain in a local position and reach the following levers: *A*, clutch lever for drive to left-hand horizontal spindle; *B*, clutch lever for drive to vertical spindles; *C* and *D*, clutch levers for feed and fast power traverse of vertical spindle saddles across rail; *E* and *F*, levers for changing speeds of all spindles; *G*, clutch lever that engages, disengages and reverses table feeds and fast power traverse, and also heads on cross-rail; *H*, clutch lever that transfers feed and fast power movements to heads on rail or to table as desired; *I*, clutch that controls engagement of table feeds; clutch that engages power feeds or fast power table movements; levers that control sliding sleeves for feed gears to give change of rate of feed; *L*, control for horizontal spindle saddle hand elevation; and spindle sleeve independent hand adjustment control.

The principal dimensions of this machine are as follows: height under vertical spindles, 54 inches; width between uprights, 71 inches; maximum width between ends of horizontal spindle, 66 inches; diameter of spindles in driving worm sleeve at large end of taper, 5 3/16 inches; independent hand adjustment of each spindle sleeve, 8 inches; maximum distance from center of horizontal spindles to top of table, 42 inches; minimum distance from center of horizontal spindles to top of table, 5 inches; and minimum distance between centers of vertical spindles, 24 inches.

CINCINNATI PLANER

The accompanying illustrations show opposite sides of a 30- by 30-inch planer, which is a recent product of the Cincinnati Planer Co., Oakley, Cincinnati, Ohio. This machine has a bed in which the space between the vees is closed up in the casting except at the gearing sections, making a very strong box sec-

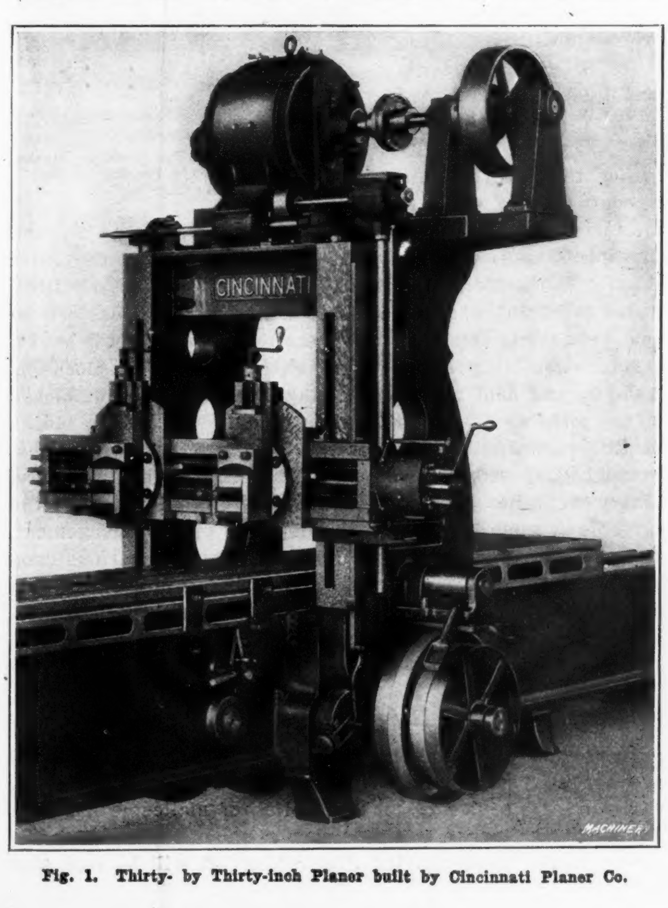


Fig. 1. Thirty- by Thirty-inch Planer built by Cincinnati Planer Co.

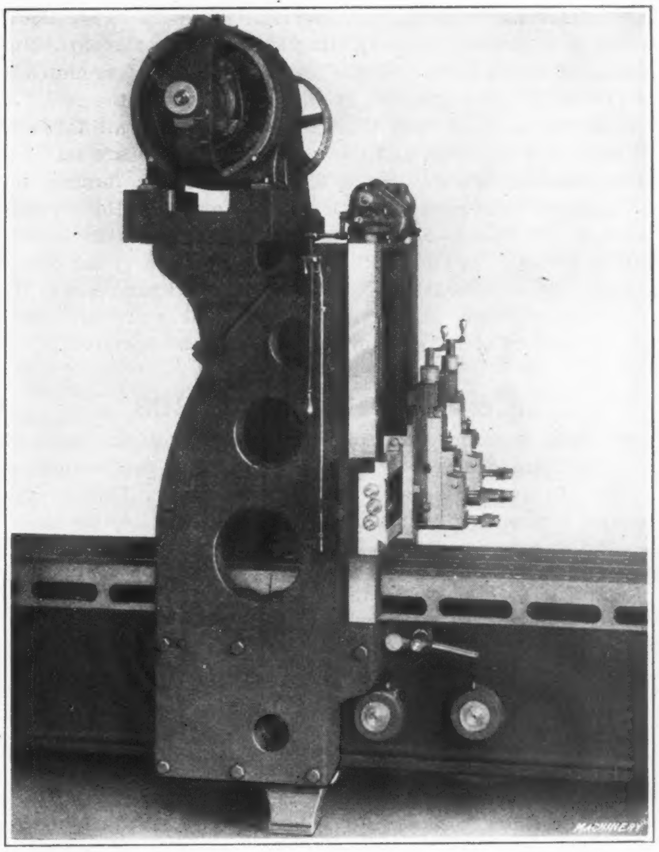


Fig. 2. Opposite Side of Cincinnati Planer, showing Improved Elevating Device

tion and eliminating possibility of injury to the operator. The bed is bored to receive the shaft bearing, and all driving gears inside the bed are supported by two bearings, thus entirely eliminating an overhung construction. The loose pulleys on this planer are equipped with self-oiling bronze bearings and the driving pulley is made of aluminum. A new design has been worked out for the belt shifting mechanism in which the cam slots are milled in the outside of a round casting. This cam is supported in a substantial bracket bolted against the housings, which serves the additional purpose of supporting the belt arms. A drip pan is attached to the lower side of the bracket to catch oil from the belt shifting device, thus leaving the belts absolutely dry.

A box type construction is used for the table, which is closed at the bottom as well as at the top. The housings are also of box section and are carried right down to the bottom of the bed. Bolts and dowel-pins fasten the housings to the sides of the planer bed, and they are further secured by a tongue and groove construction. A departure has been made from preceding practice in working out the design of the cross-rail. A reinforced arch at the back is made a true half circle and this section is used to give additional strength for the torsional stresses imposed by overhung cutting tools. The saddle is taper gibbed at the top and the clapper box is provided with a rectangular shaped clamp instead of the circular clamp arrangement previously employed.

Figs. 1 and 2 show a machine provided with rapid power traverse to the rail heads. This feature is an advantage for the rapid manipulation of the heads and has been found quite a time saver. The drive is taken from the top of the machine through a pair of bevel gears and a friction clutch, which is manipulated from the end of the cross-rail within easy reach of the operator at all times. The device is absolutely foolproof in that it is impossible to engage the feed and rapid traverse simultaneously. A set of pads is provided for the housings onto which the brackets can be fastened for motor drive at any time after the machine has been placed in service. Ordinarily this planer is equipped with a two-speed countershaft giving two cutting speeds and constant reverse.

Fig. 2 shows the left-hand side of the machine, and in this illustration the automatic limit stop for the elevating device may be seen. This is an added feature of the present Cincin-

nati planer and consists of a vertical rod with two collars, which is connected to the shifting levers of the standard Cincinnati elevating device. These levers operate friction clutches at the top of the planer for raising and lowering the rail. A bracket is fastened onto the back of the cross-rail through which this rod passes, and the collars on the rod are set to a predetermined height. It will seen that when the bracket on the rail comes into contact with one of the collars, the vertical rod is moved either up or down, thus causing levers on the elevating device to be moved in either one direction or the other, thereby disengaging the frictions when the rail has reached its maximum position in either direction. All gears are thoroughly covered to provide for the safety of the operator.

S. & S. GAGE STANDARDS

Manufacturers have placed far less reliance in the value of so-called "trade secrets" since the practical application of science in industrial and engineering work. This is the natural sequence of events because the scientist is able to determine the details of manufacturing processes and to find out why certain results are obtained; he attaches no value to methods which his training does not show him are based upon scientific truths. Nevertheless, there are certain lines of manufacture, the control of which has remained in the hands of a few men in Europe, and the reputation of these manufacturers has become so celebrated that it has been almost generally acknowledged that these men are the only ones who are capable of producing satisfactory products of certain kinds. Typical examples are the manufacture of high-grade steel balls and the production of gage standards.

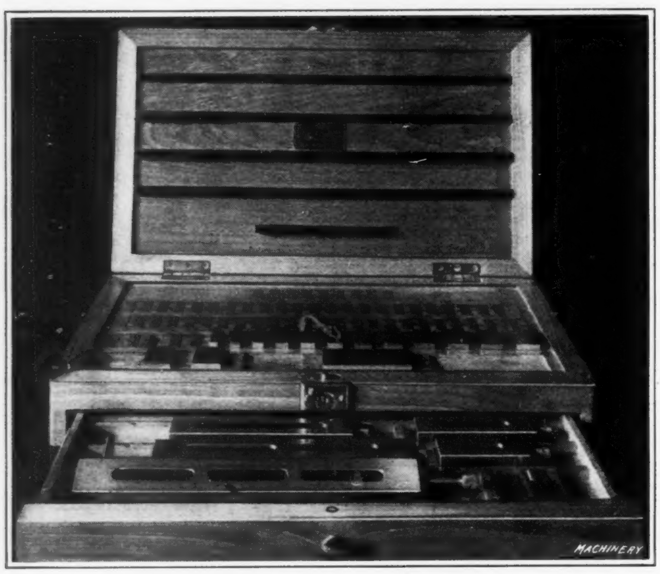


Fig. 1. Set of Gage Standards in Case, with Series of Blocks assembled in Holder ready for Use

The cases mentioned are industries that have flourished in different sections of Europe, but since the war cut off exports from those countries, necessity has once more proved the mother of invention, and the enterprise of American manufacturers who have branched out into these lines has been crowned with a large measure of success. It will undoubtedly prove of considerable interest to manufacturers in this country who use gage blocks to learn that very satisfactory standards of this kind are now being made by Wismach & Co., New York City, and that Schuchardt & Schütte, 90 West St., New York City, are the sales agents. Mr. Wismach has spent practically his entire life in this line of work. He started in this industry abroad, where he was engaged in making gage standards for testing the accuracy of rifle parts. Later he came to America, where he took up the same line of work.

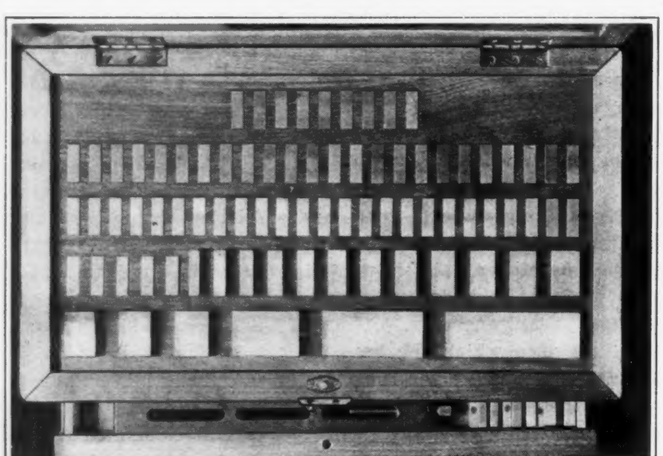


Fig. 2. Close View of Gage Blocks in Case shown in Fig. 1

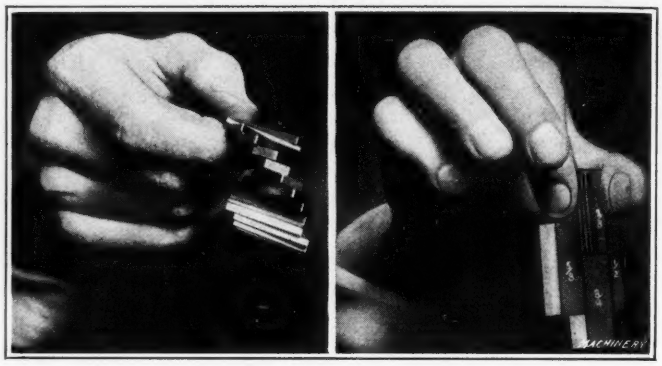


Fig. 3. Accuracy of Finish of Gage Blocks allows Air Pressure to hold them together

It will be apparent from Figs. 1 and 2 that these gage blocks are packed in a substantial wooden case which affords adequate protection against damage while the blocks are not in use. A feature of this case is that a lower drawer is provided with spaces for the various sizes of holders in which the blocks are assembled for use. The spaces are made of sufficient size so that a holder with a set of blocks assembled in it may be placed in the drawer over night, in case the same assembly of gage blocks will be in use again the next day. This is the means of saving a lot of time in assembling and taking apart sets of blocks. The precision with which the S. & S. gage standards are finished is indicated by the fact that if two blocks are rubbed together they will remain in contact; this is due to the fact that all the air is expelled from the surfaces between the blocks, and thus the air pressure acting from the outer sides holds the blocks together. This condition is clearly illustrated in Fig. 3, which shows how a number of blocks can be held together in this way. A severe test of accuracy is shown in the same illustration, where a combination of blocks is made up and held by the projecting ends of one set of blocks at the middle. It will be evident that unless all the blocks in this combination were of absolutely the proper size, it would be impossible to hold them in this way, because those that were either over size or under size would prevent the surfaces of some blocks from coming into proper engagement. These gages are made in ten different sets with various combinations of gage blocks and holders to meet the requirements of shops engaged in the production of different classes of work. The blocks are guaranteed accurate to 0.00001 inch at 62 degrees F.

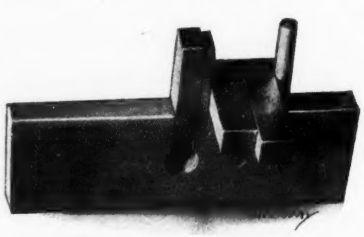
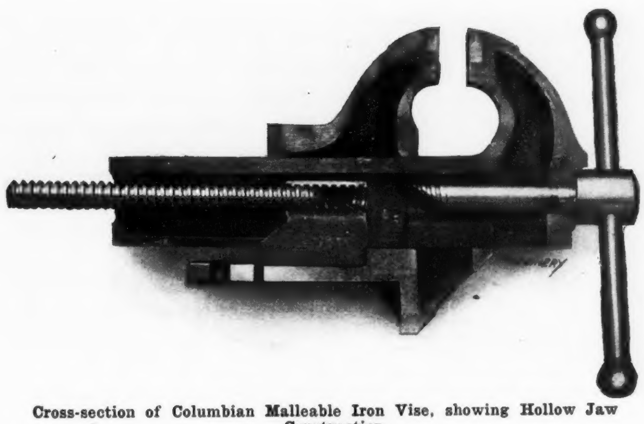


Fig. 4. Example of Use of Gage Blocks, showing how Air Pressure holds Blocks together

COLUMBIAN MALLEABLE IRON VISES

To provide additional strength and resistance against breakage through sudden shocks, the Columbian Hardware Co., Cleveland, Ohio, is now making a line of malleable iron machinists' vises, a cross-sectional view of one of these vises being shown in the accompanying illustration. It will be seen that



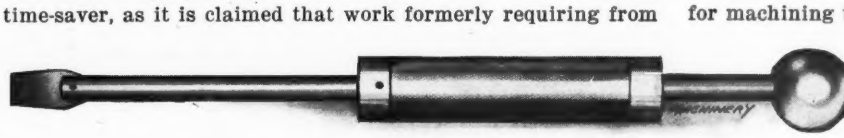
Cross-section of Columbian Malleable Iron Vise, showing Hollow Jaw Construction

the vise jaws are hollow, which is the means of accomplishing a great deal more than merely lightening the vise. This is due to the fact that the hollow jaw construction provides for obtaining the malleable iron skin on both the outside and inside of the jaws, and it is a well-known fact that the strength of malleable iron is due to annealing the surface of the metal. Hence the hollow jaw construction is claimed to virtually double the strength by having twice the amount of surface annealed to convert it into malleable iron.

The jaws are faced with tool steel plates secured in place by screws, and each part of a given size vise, including the steel jaw plates, the screw, handle, nut, and, in fact, the entire jaw, is interchangeable with corresponding parts in other vises of the same size. The screw is forged from one solid piece of steel, of which the head is an integral part. The manufacturers of this vise claim that it is practically indestructible. It is said to be absolutely impossible to break the vise by pounding it with a hammer or by subjecting it to other severe shocks; also, it is claimed that the metal in the vise will not be bent by such treatment.

JONES-MOWRY FROSTING TOOL

A tool designed for frosting and spotting finished surfaces on machinery has recently been developed by the Jones-Mowry Mfg. Co., Jackson, Mich. The use of the tool calls for no particular skill, so that frosting and spotting can be done by other than experienced men. This tool is said to be a great time-saver, as it is claimed that work formerly requiring from two and a half to three hours can be done in twenty minutes. The tool is made of steel tubing which has ample strength and durability. Two steel tubes and a rod holding the cutting tool comprise the essential parts. The outer tube is knurled to afford a suitable hand-hold, and the inner tube, which is hardened, contains an angular groove in which runs a pin on the central rod. Moving the hand up and down, while the tool rests on the surface to be frosted, imparts a vibratory motion to the tool, which should be held at an angle of 45 degrees. By honing the tool different ways numerous designs can be obtained including the "double gooseneck" and "halfmoon." Heretofore these designs have always been made by hand, but with the Jones-Mowry tool they can be done more rapidly and more accurately.

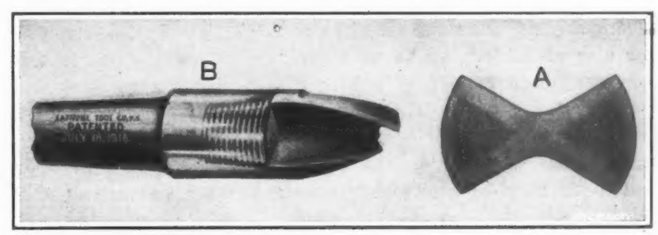


Frosting and Spotting Tool made by Jones-Mowry Mfg. Co.

LATROBE HIGH-SPEED DRILLS

The following is a description of high-speed drills made by the Latrobe Tool Co., Latrobe, Pa., and sold by McKenna Bros., Ross St. and First Ave., Pittsburg, Pa. These are two-piece twisted and milled drills and may be furnished with either a Morse taper or a straight shank; the working part of the drill is made of "Red Cut Superior" high-speed steel and permanently inserted into a carbon tool steel shank. Referring to the accompanying illustration, it will be seen that a transverse section of the double-grooved high-speed steel bar from which the drill is made is shown at *A*; and when this bar is twisted it gives approximately the correct shape for the grooves of the drill. The shaded portions of this cross-sectional view indicate compression of the steel, which is about 1/8 inch wide at the outer edge and meets at the center, so that when the steel is twisted the toughest part of this section is in the exact center and surrounding portion.

In conducting the process of manufacture, the next step is to center the blank at each end and support the work on centers in a milling machine to provide for taking a cut in each groove. This insures having the grooves of equal depth and properly tapered from the point to the shank. After this operation has been completed, the groove is ground by hand and polished. A phantom view of the section of the drill containing the joint between the drill and carbon steel shank is shown at *B*. This shank is fitted to the drill with a taper thread and the two parts are firmly connected by brazing. Drills are made by this method in all sizes from 37/64 inch to 3 inches,



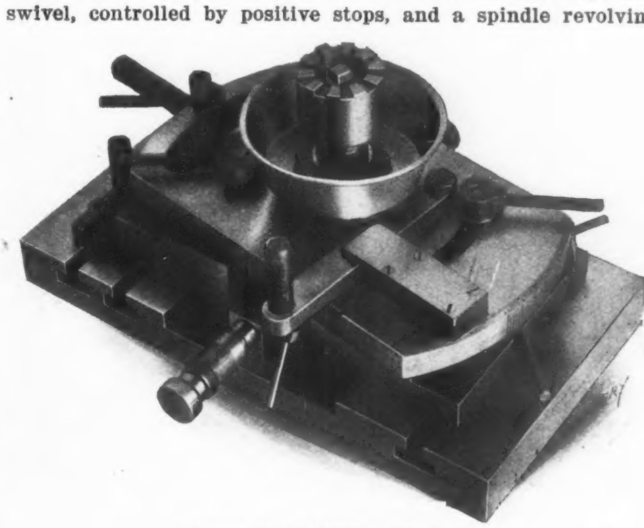
Cross-sectional View A of Double-grooved Bar and Phantom View B of Joint between Drill and Shank

inclusive; drills 9/16 inch and under are made of high-speed steel and electrically welded to a carbon steel shank, after which they are finished according to the practice followed in manufacturing milled one-piece drills.

ADAMS CLUTCH MILLING ATTACHMENT

William C. Adams, 40 Cleveland Ave., Hartford, Conn., has made a departure from standard methods of manufacturing and selling, in working out a method of placing his clutch milling attachment on the market. Instead of selling the complete attachment, his plan is to deliver rough castings to the customer, together with a set of blueprints that give instructions for machining the castings and assembling parts of the attachment. This attachment is intended for use on a hand milling machine, and the chief claim made for it is that it provides for performing clutch milling operations on a moderate priced machine, leaving the universal millers and other large, expensive machines free for the performance of those classes of work for which they are really required.

Reference to the accompanying illustration will show that this clutch milling attachment consists of a base, slide and swivel, controlled by positive stops, and a spindle revolving



Adams Clutch Milling Attachment

within the attachment. Any type of clutch with up to 32 teeth can be milled with this outfit. It can also be used for regular milling operations usually done with an indexing attachment. The spindle has a Brown & Sharpe taper hole, so that standard arbors, etc., may be used.

DETROIT UNIVERSAL CARD-HOLDER

For use in attaching cards to truck loads of work which are being transferred from department to department in industrial plants, and for a great variety of other purposes where it is desired to attach various forms of instruction or identification cards, the Detroit Stamping Co., 955-957 W. Fort St., Detroit, Mich., is now making a universal card-holder, which is shown in the accompanying illustration. Features of this device are that one size of holder can be used for various sizes of cards, and they may be arranged to hold cards in either a vertical or a horizontal position. These card-holders take up very little space while in transit or in the store-room. The holders are fastened so that nearly the entire card is exposed to view, and cards may be easily put in or taken out as desired.

Card-holder made by Detroit Stamping Co.

FULTON TAPPING AND DRILLING MACHINE

The Fulton Foundry & Machine Co., 25 Furman St., Brooklyn, N. Y., has just added a new type of tapping and drilling machine to its line of tapping machines. This is a vertical type, having an adjustable work-table and movable head. The tap or drill, as the case may be, can be fed by either hand or foot, and the head which carries the friction disks, chuck, tap, etc., is counterbalanced by a weight giving a constant unvarying balance. The friction pulleys are carried by ball bearings which take both the thrust and radial loads. Friction surfaces for the tapping drives are flat, giving great sensitiveness, and they are concentric with the spindle, thus doing away with spindle strains.

The machine is extremely simple, having no gears, positive clutches or tension adjusting devices. It will tap or drill holes up to 3/8 inch in diameter. The change from tapping to drilling can be made in less than one minute, and in no way affects the tapping efficiency. Drill speeds may be had up to 2000 R. P. M. and tapping speeds up to 1000 R. P. M. Two speeds are available for either tapping or drilling. The machine is capable of drilling a 7/32-inch hole through 1-inch brass in eight seconds. A stop is provided for drilling or tapping to a fixed depth, and a self-oiling countershaft is provided, with an improved belt shifter, for the bench type machine. The belt shifting device is carried on the jackshaft for pedestal type machines, enabling it to be set directly under a lineshaft.

DEMCO HIGH-SPEED DRILLING MACHINES

In the October, 1916, and February, 1917, numbers of MACHINERY, descriptions were published of bench and floor types of sensitive drilling machines built by the De Mooy Machine Co., 706 Frankfort Ave., N. W., Cleveland, Ohio. Recently this concern has added to its line a high-speed ball bearing drilling machine of similar design, which is also built in bench and floor types as illustrated herewith. These machines are especially adapted for drilling small holes where it is necessary to have the drill run at an extremely high speed in order to cut through the metal instead of forcing the drill through the metal. Operation at high speed not only increases production but reduces the breakage of drills. These new "Demco" drilling machines are fully equipped with ball bearings and adapted for operation at a maximum speed of 12,000 revolutions per minute.

They are particularly adapted for drills from 3/16 inch in diameter down, but drills from 3/16 to 3/8 inch in diameter may be used at slower speeds, three changes of speed being provided. The spindle is provided with a carefully balanced three-jaw geared nut chuck of the key type. Changes of speed are made by moving a lever on the sector which fits into a rack and allows changes to be made quickly. Two pulleys running on ball bearings are attached to the idler with a belt adjust-


Tapping and Drilling Machine built by Fulton Foundry & Machine Co.

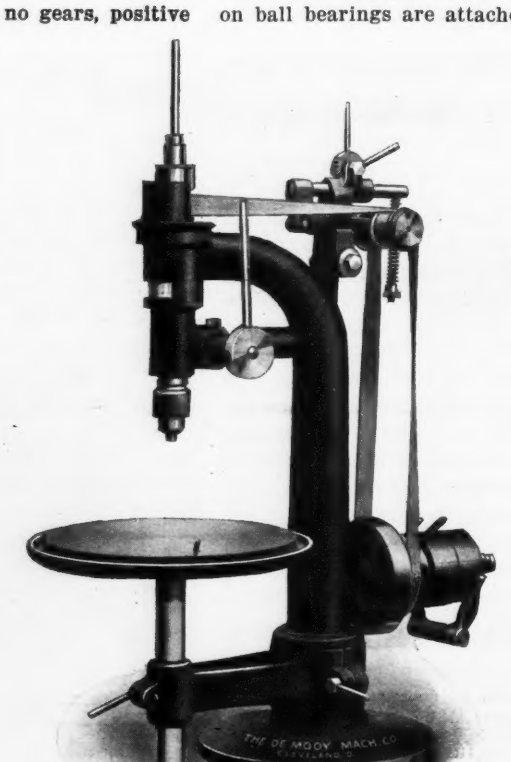


Fig. 1. "Demco" No. 22 Bench Type of Ball Bearing Drilling Machine

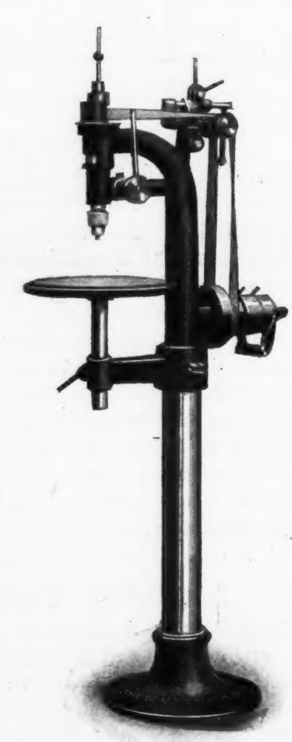


Fig. 2. "Demco" No. 23 Floor Type of Ball Bearing Drilling Machine

ment having an automatic take-up. Power is transmitted by an endless flat canvass belt, which gives great flexibility for the high speed at which it is required to travel. The spindle is made of high-carbon, heat-treated steel, accurately ground and carried in ball bearings.

Fig. 1 shows what is known as a No. 22 bench machine, the principal dimensions of which are as follows: distance from spindle center to column, 7½ inches; traverse of spindle, 4 inches; traverse of table, 7 inches; maximum distance from chuck to table, 8¾ inches; minimum distance from chuck to table, 1 inch; diameter of working surface of table, 12½ inches; diameter of table outside oil-groove, 14 inches; diameter of spindle, 7/16 inch; diameter of spindle pulley, 1½ inch; diameters of countershaft cone pulley steps, 3, 4½ and 6 inches; diameter of driving pulley, 4 inches; maximum spindle speed, 12,000 R.P.M.; maximum countershaft speed, 3000 R.P.M.; height of machine, 34 inches; and weight of machine, 135 pounds. Fig. 2 shows the No. 23 floor type machine, and the following dimensions of this machine differ from those already given for the bench type machine: distance from spindle to center of column, 7 inches; traverse of table arm, 25 inches; height of machine, 65 inches; and weight, 200 pounds.

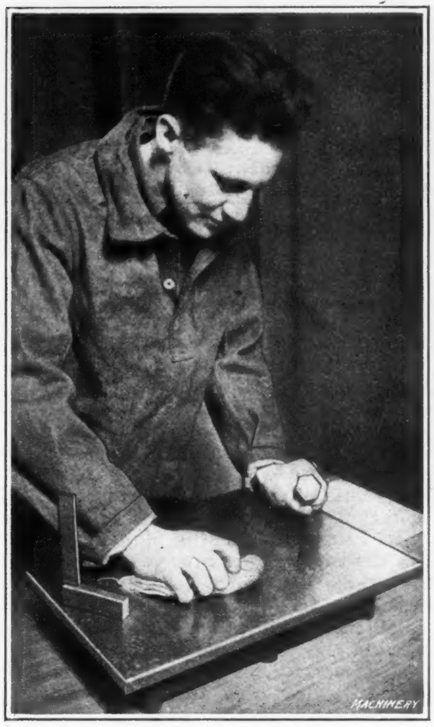


Fig. 1. Surface Plate made by T. P. Walls Tool Co.

Fig. 2. One Use of T. P. Walls Tool Co.'s Surface Plate

KELLY "PRODUCTION" TOOLS

One of the recent additions to the line of tools manufactured by the Kelly Reamer Co., Cleveland, Ohio, is a line of what are known as "production" tools. It will be seen from the halftone illustration, Fig. 1, that these are multiple boring

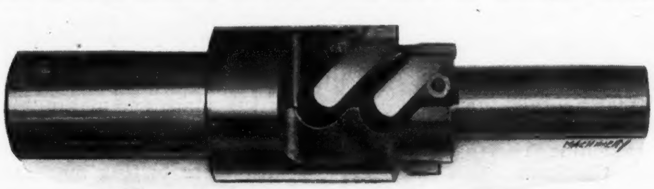


Fig. 1. Kelly "Production" Tool for Simultaneous Performance of Five Operations

and facing tools, provided with pilots for maintaining concentricity. The tools are adjustable, and in the case of the tool illustrated herewith, five operations, *i. e.*, boring and facing operations for diameter and depth, may be performed at one pass of the turret. Fig. 2 illustrates work for which this tool is especially adapted, and these two illustrations of the tool and its work will fully explain the purpose of this new product of the Kelly Reamer Co. without requiring further description.

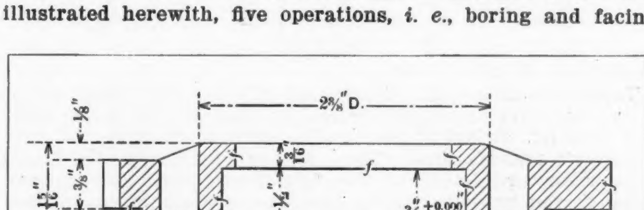


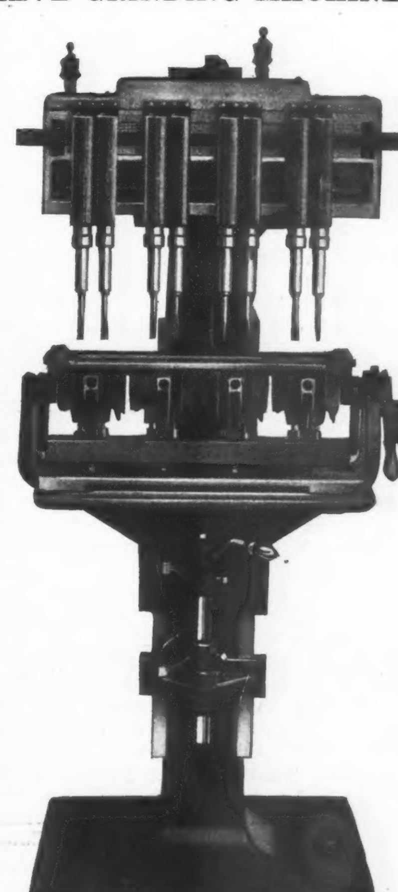
Fig. 2. Work done by Kelly "Production" Tool shown in Fig. 1

T. P. WALLS SURFACE PLATES

T. P. Walls Tool Co., 75 Walker St., New York City, is now selling iron surface plates which are thoroughly seasoned before the plates are machined in order to assure the maintenance of accuracy. To further insure durability and the maintenance of an accurate and flat surface, the under side of these plates is well ribbed. After completing the machining operation, each plate is carefully inspected and tested. A substantial wooden cover is provided to protect the finished surface while the plate is not in use. Twelve different sizes of plates are made, covering a range of 6 by 6 inches minimum up to 24 by 48 inches maximum.

BRIERLEY VALVE GRINDING MACHINE

The Brierley Machine Co., 1736 E. 22nd St., Cleveland, Ohio, is now building an eight-spindle valve grinding machine, which forms the subject of the following description. On this machine a quick-acting mechanism is provided for raising and lowering the table to engage and disengage the work, and to permit the cylinders to be removed from the machine. Another feature is adjustable rotation of the ball bearing spindles. This machine has sufficient capacity to grind at one time four complete cylinders of two valves each, either single or *en bloc*. The spindles are adjustable with a minimum center distance of 1¾ inch. An interesting feature of this machine is the



Brierley Eight-spindle Valve Grinding Machine

enclosed pulley clutch, which enables the operator to start and stop the drive by moving a lever located at the top of the machine. Suitable adjustment is provided for grinding the valves in any automobile cylinder. The machine is driven by a 2½-inch single belt and can be arranged for motor drive using a two-horsepower constant-speed motor. The weight of the machine is 1200 pounds.

NEW MACHINERY AND TOOLS NOTES

Forging Press: Morgan Engineering Co., Alliance, Ohio. A steam-hydraulic forging press built in various sizes up to 12,000 tons pressing capacity. These presses are adapted for the rapid production of solid homogeneous forgings ranging in size from small die forgings up to the larger sizes of shafts, etc.

Air Compressor: National Motor Supply Co., Cleveland, Ohio. This machine is of the double-opposed type with a 2-inch bore and 2½-inch stroke. Both pistons and the yoke are cast in one piece, and the crankshaft is a drop-forging. All bearings are bronze-bushed and the cylinders are water-cooled.

Quick-acting Vise: F. C. Sanford Mfg. Co., Bridgeport, Conn. A vise combining the old-style screw with a quick-action cam. The adjusting screw runs in a floating nut to which the cam is attached. In operation, the vise jaws are brought up to the work by a thumb-nut; then the operation of the cam locks the work tightly in place.

Compound Bench Plates: A. P. McCulloch Machine Co., Boston, Mass. A compound bench plate especially designed for the use of machine shop inspectors. It consists of a flat plate, to one end of which is attached a vertical plate equipped with T-slots, vees, round holes and slots. Seven standard plugs of different sizes are furnished which fit into the holes and slots in the angle-plate.

Duplex Drilling Machine: Martin Machine Co., Greenfield, Mass. This bench drilling machine is designed especially for drilling, reaming, milling and countersinking operations on small metal goods. The spindles are hardened and ground and run in taper bronze bearings. They run in a sliding yoke controlled by a foot-lever which is so adjusted that either or both of the spindles may be operated at one time.

Inclinable Power Press: Loshbough-Jordan Tool & Machine Co., Elkhart, Ind. An open-back inclinable power press equipped with a solid-web flywheel which has a three-point clutch. A toggle control used in connection with the clutch prevents the press from repeating; and upper and lower knock-outs are provided. This press occupies a floor space of 34 by 43 inches and weighs 2000 pounds.

Tool-room and Heavy-duty Lathes: Joseph Crawford Jr. Co., Erie, Pa. The tool-room lathe swings 16½ inches over the ways and 9½ inches over the carriage; and the capacity between centers is for work up to 36 inches in length. The quick-change heavy-duty lathe swings 21½ inches over the bed and 14½ inches over the carriage; and the capacity between centers is for work up to 46 inches in length.

Lathe Accessories: Mechanical Development Co., Los Angeles, Cal. A line of four lathe accessories which include a universal tool-holder, an extension grinding machine, a boring-bar, and a universal tool grinding attachment. All of these accessories were designed for use on the same machine, and their employment singly or in combination increases the range of work that can be handled on a lathe.

Drill Chuck: Quick Action Chuck Co., Grand Rapids, Mich. A quick-acting drill chuck that enables the operator to remove a tool and substitute another in its place while the machine is in operation. When the operator wishes to change the tool, it is merely necessary for him to lift a collar to enable the collet to be removed from its housing and another one to be inserted. After this has been done, lowering the collar locks the second collet in place.

Industrial Truck: J. E. Haschke, 115 W. Redondo St., Los Angeles, Cal. A storage battery industrial truck with the motor mounted on a yoke that also carries the front wheel, this wheel being of the caster type; a high-speed electric motor is used, which can be operated at various speeds without requiring the use of resistance in the circuit or paralleling the field coils or the cells of the battery. This truck weighs approximately 1500 pounds.

Cleaning Tank: Spicer Tabulating Machine Co., Washington, D. C. A cleaning tank for use in cleansing tools and small parts. This tank is for use in removing oil, grease, chips and other dirt with gasoline or other inflammable liquids without involving danger of fire. A self-closing cover is fitted to the top of the tank, and when this is in place it brings into action a pump that raises fluid from a storage chamber and discharges it against the work to be cleaned.

Cold Saw: Earle Gear & Machine Co., 4705 Stenton Ave., Philadelphia, Pa. A special type of Lea-Simplex cold metal saw which has been illustrated and described in MACHINERY. The present machine is designed for handling bars in multiple. There is a cradle in the form of a carriage running on rollers on a structural steel frame at the rear of the machine. By means of this carriage and a handwheel operating a lead-screw, work is fed to the successive positions for cutting.

Industrial Truck: Covel Mfg. Co., Benton Harbor, Mich. A storage battery industrial truck primarily designed for use in saw mills, lumber yards, etc. However, this truck can also be employed in industrial plants for conveying loads of any kind that may be placed on wooden platforms or supported in a special carrier. A feature of this truck is that it provides for depositing the load in exactly the desired position. This truck can move either forward or backward and can be turned in a very small space.

Turret Lathe: Oliver Machinery Co., Grand Rapids, Mich. A 16-inch heavy-duty turret lathe which is of the double back-geared type driven by a three-step cone pulley and 3¾-inch belt. The headstock column is provided with a door and corner brackets to support shelving. A close fitting stud supports the turret head, and it is claimed that except for taking very heavy cuts, it is unnecessary to use the clamping lever at each operation. Forcing the turret slide back by means of a handwheel causes the locking plunger to be automatically released and the turret to be revolved to the next station.

Portable Elevator: New York Revolving Portable Elevator Co., Jersey City, N. J. A machine known as a "revolvator" which consists of a portable elevator with a swivel connection between the truck and structure on which the elevating platform is carried, to provide for rotating the platform to face in any desired direction. This outfit is used for stacking materials in industrial plants and warehouses, for transferring heavy dies from storage racks to the bolsters of machines on which they are to be used, for setting up heavy electric motors and countershafts, and for numerous similar purposes.

Box-tool: W. K. Millholland Machine Co., Indianapolis, Ind. A box-tool for turret lathes, which has a turning capacity of from ½ up to 1¾ inch bar stock. The turning tool is clamped down on a hardened steel tool-block by two set-screws, and the toolpost is a malleable iron casting supported on a large hardened and ground steel stud. By means of a tool-clearing cam lever the operator can release the tool on the back stroke of the turret so that no tool marks are left on the finished surface. Two adjustable stock-supporting rollers in this box-tool are provided with both adjustable and clamping screws.

Forming Press: Toledo Machine & Tool Co., Toledo, Ohio. A double-action toggle press especially constructed for use in forming side rails for automobile frames, and for similar operations which call for a combination of accuracy and uniformity. This machine is self-contained and employs only two motions; one slide comes down and clamps the flat blank or sheet, thus holding the blank flat, while the second movement of the machine forms the sides of the channel or frame. The work is lifted clear of the die so that it may readily be swept off without the necessity of prying out the work, which would result in the loss of a lot of time.

Cutter and Tool Grinder: Factory & Mill Supply Co., Boston, Mass. To provide for grinding cutters, small tools, fixtures, gages, and similar classes of work, this company is selling a universal cutter and tool grinder. On this machine the spindle runs in phosphor-bronze bearings which may be adjusted to provide compensation for wear. All feed movements are furnished with the usual indicating dials. Provision is made for sliding the tailstock on the base of the machine, and the tailstock spindle is also adjustable. An internal grinding attachment is furnished for use on the machine, making it adaptable for handling both internal and external work.

Machine Tool Testing Equipment: Fosdick Machine Tool Co., Cincinnati, Ohio. To provide means for testing machine tools without requiring them to be taken to some place in the shop where power is available, this company has developed a testing outfit that consists of an adjustable speed motor mounted on a three-wheel truck. This truck is set at right angles to the machine so that the motor may be belted to the machine to be tested. Using an idler pulley provides for obtaining satisfactory results with a short belt. A friction clutch controls the transmission of power and four lag-screws in the truck are driven into the floor to anchor the testing outfit securely in place.

Tapping Attachment: Hammond Mfg. Co., Cleveland, Ohio. A tapping attachment developed for use on the high-speed, ball bearing, swinging arm radial drilling machine of this company's manufacture. There are two pulleys in the head, one for forward drive and the other for reverse, both pulleys being driven by open endless chain belts which are furnished with an adjustment for tension. The spindle drive is through a double cone friction which is ordinarily held in contact with the lower or driving pulley by means of three springs. When the tap has been advanced to the desired depth, the friction cone is shifted into contact with the upper or reverse pulley, this result being obtained by pushing down a horizontal lever under the head. This results in backing out the tap at a 50 per cent increased speed.

WAR REVENUE AND SECOND-CLASS POSTAGE RATES

BY M. J. O'NEILL [1]

The House of Representatives passed the war revenue bill, May 23, practically as the bill was presented by the Ways and Means Committee two weeks earlier. The vote on the bill was 329 to 76, with 4 voting "present." Readers are familiar in a general way with the various provisions of this important bill, which undertakes to raise by direct taxes the sum of $1,870,000,000 for war purposes.

There is a decided difference of opinion among financiers and other competent people as to the necessity for raising so large a sum of money at the outset; but there is absolutely no doubt in the mind of any live American that we should raise all the money needed now and hereafter to make war, since we are in it, with all the vast resources and unparalleled power of this great democracy. If ten thousand millions of dollars instead of two thousand millions are needed, the people of this republic will furnish the money and will be found equal to the utmost effort and the greatest sacrifices. They always have been. It is proved by the battlefields of this hard-fought land, the graves of its dauntless dead, the unburied heroes of many a gallant sea battle, whose dirge the indifferent tides ceaselessly sing, making no distinction between those who fought for and those who fought, blindly and bravely enough, against democracy. This is a heroic, if peace-loving, land, and whenever the standards are raised our people flock to them, prepared to go through.

But in common with other peoples to whom war is an unfamiliar and unattractive business, we put off doing anything about it until too late, and when we begin we always make serious blunders. We appear to be making a characteristic start in the new revenue bill. This bill is, or should be, primarily a taxation measure. It should have no other purpose. The only reason for it is to raise the money to pay for the war. It is out of the labors and business of the people that wars are and must be paid for. There are no other sources of revenue. The greatest conqueror that ever lived and waged war maintained and equipped his armies out of the produce of the people. However he got it, that was what fed and equipped his armies. Very little of accumulated wealth is in form to use for war purposes. And as it is out of the current labors and business of the people that war must be paid for, the very first consideration for statesmen is to so lay their measures of taxation that the wheels of industry will continue to revolve. Taxes on profits and incomes are wise, if not too excessive; for businesses and individuals should be perfectly willing to pay their full share of war costs out of their profits and incomes. But taxes which have the effect, whatever their purpose, of destroying a business are not the offspring of broad and sagacious statesmanship. Yet the effect of the revenue bill provisions in regard to the postage rate on periodicals would be to harm seriously, if not destroy, the industrial press of this industrial nation.

Going back to the beginnings of this republic, a postage rate of one cent per pound was established on second-class matter on account of its educational value to the people; under that favorable rate journals representing practically every product and industry have been developed, and have effectually stimulated the development of the industries they represent. The people have supported these business and technical journals, which is proof of their practical educational value; and the benefit of the favorable postage rate has been passed to readers in subscription rates so low that the total amount subscribers now pay MACHINERY, for example, is less than the cost of the paper upon which the reading pages are printed, to say nothing of the cost of the journalistic service, which has been expanded and developed to an extent undreamed of by publishers twenty years ago. We need hardly emphasize this to readers of MACHINERY.

The proposal seriously made by Congressman Moon, holding the responsible position of chairman of the Post Office Committee of the House, was that periodicals be placed on the parcel post basis, parcel post zone rates applying to each copy mailed. Under this plan it would cost 36 cents to send a copy of MACHINERY to San Francisco, 20 cents to Chicago, 15 cents to Cincinnati, and 31 cents to Denver. The subscription price of MACHINERY is slightly under 17 cents per copy. Alarmed by this extraordinary proposal, the trade and technical press of the country sent a committee of representative publishers to explain to members of the House exactly what this meant to one of the country's great industries. Thanks to the energetic efforts of this committee, and the spirit of fairness which dominates the House in general, the Moon proposition failed of adoption. But the influence behind the persistent efforts to lay this crushing blow upon the already heavily burdened trade and technical press, succeeded finally in getting into the revenue bill provisions greatly increasing the postage rates on periodicals. The newspapers are hardly affected by the zone principle of postage, for the reason that practically all their circulation is local, and locally the rates are scarcely affected. Consequently, the newspapers, with hardly any exceptions, are silent on this proposition to so heavily tax the industrial press of the country. It is clear that if the facts are to be adequately laid before the people of the country, it must be done chiefly by the business press, which is our sole reason for stating the facts here.

The present postage on a copy of MACHINERY is about three cents, and we have for a long time favored a higher rate. Unfortunately, post office accounting is of such a character that it is impossible for anyone to tell with any degree of accuracy how much per pound it costs to handle and deliver periodicals. If that can be determined, that cost, regardless of the educational nature of the technical press, should be paid in the postage rate. That is our belief and we will stand for that principle always, whatever it may mean to MACHINERY. But under the revenue bill which passed the House May 23, the annual postage rate on MACHINERY goes up from a total of $7200 a year to about $20,000. Under that rate it will cost 9 cents to send a single copy of MACHINERY to Cleveland or Cincinnati, 12 cents to Omaha, 15 cents to Denver, and 18 cents to San Francisco. These increases are from 300 to 600 per cent. Yet no one in the post office or in Congress knows what relation these new and punitive postage rates bear to the actual cost of handling and delivery.

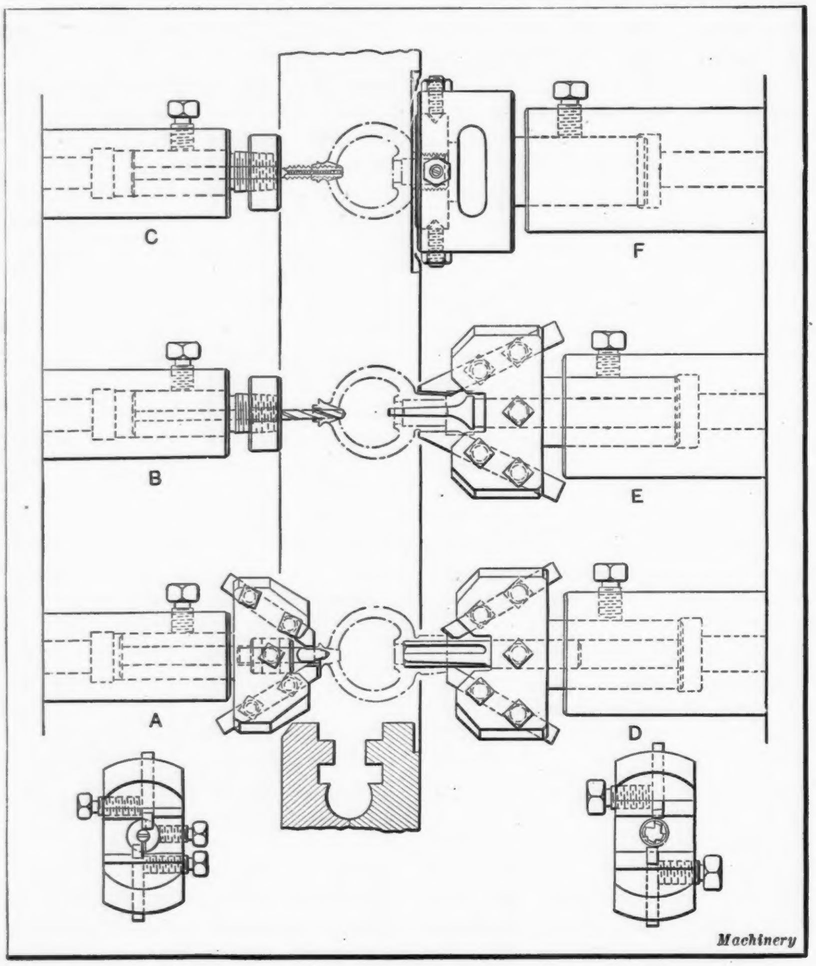
Publishers of journals like MACHINERY are now paying 100 per cent more for paper than a year or two ago, and all other costs have increased from 25 to 60 per cent. The Postmaster General himself recommended that no increase be made at present in the postage rate on second-class matter, but there seems to be a determination somewhere to lay this toll upon the industrial press of the country. We are not inclined to attribute unworthy motives to our representatives in Washington, who have their troubles and must work out their war revenue problems, which are new and involve manifold difficulties. But no industry has been singled out for such destructive legislation as the publishing of periodicals. These publishers, like all other business people, must pay the profits and income taxes, and to a greater extent than almost all others, will pay the government the heavy taxes represented by the increases in postage on letters, post cards, circulars, etc. To these taxes, however, publishers make no opposition. They apply to all, and each pays according to the benefits derived. But the destructive taxes laid down for periodicals, in the form of second-class postage rates, are leveled against a single industry, and there is no justification for them.

The bill is now in the hands of the Senators, and readers of MACHINERY who believe in fair play, and who realize, as politicians do not, the practical educational value of journals like MACHINERY, should consider it a duty to write or wire the Senators from their state, protesting against this heavy increase in the postage rates on trade and technical journals. It is generally believed that the Senate will pass the bill by June 10 or earlier. The Senators are considered open-minded on the proposition.

[1] General Manager of MACHINERY.

MACHINING SPRINKLER HEADS

The method of machining sprinkler heads used by the largest manufacturers is somewhat different from the methods described in MACHINERY for September, 1916, and May, 1917. While the sprinkler heads are finished well, the productions are much below standard commercial practice. These pieces are now handled by makers of large quantities of sprinklers in one setting on No. 53 New Britain automatic chucking machines, manufactured by the New Britain Machine Co., New Britain, Conn. The only operation not completed on this machine is the back-facing of the top of the orifice; this is done in a small lathe provided with suitable stops on both the cross- and the lengthwise feeds.



Tool Lay-outs for machining Sprinkler Heads on Automatic Chucking Machines

The automatic chucking machine is of the double-head type and has six spindles. The operations are as follows: Left-hand head: Spindle *A*, spot, turn and face; spindle *B*, drill; spindle *C*, tap. Right-hand head: Spindle *D*, bore face and chamfer; spindle *E*, bore and taper-turn; spindle *F*, thread. As all the operations are performed at the same time, a completed piece is turned out in the time of the longest operation. The production is from 280 to 350 pieces an hour. Spindles *A* and *B* make 1050 revolutions a minute, and have a 3/8-inch feed and a 1 3/4-inch stroke; spindle *C* makes 300 revolutions a minute; spindles *D* and *E* have a 1 1/8-inch feed, a 1 3/4-inch stroke, and a speed of 300 revolutions per minute; while spindle *F* has a speed of 200 revolutions a minute. End views of tools *A* and *D* are shown at the bottom of the illustration.

As the opposite spindles in the two heads of the machine are in alignment, the operations on the two ends of the sprinkler head are in line and concentric. Furthermore, as the operation of the machine is entirely automatic, except for chucking and unchucking the work, all pieces are sure to be exactly alike, which means much on work that is subjected to rigid inspection by insurance underwriters. With this method of machining, it is possible to face and turn the small end of the sprinkler head while the other operations are going on. These operations are usually necessary, and require a separate setting when handled by the methods described in the articles mentioned.

* * *

MASTER MECHANICS' AND MASTER CAR BUILDERS' CONVENTIONS CANCELLED

The committees of the American Railway Master Mechanics' Association and the Master Car Builders' Association have decided to cancel the annual convention which was to have been held in Atlantic City in June; the war emergency makes it imperative for all railway employes to be at their posts. Many other railway associations have cancelled their annual meetings on account of the present emergency.

GUTTA-PERCHA

Gutta-percha is derived from the secretions of the bark of certain trees found in the Straits Settlements and the Malaccan Archipelago. At temperatures between 32 and 80 degrees F., it resembles dark brown leather; at temperatures above 80 degrees F., it softens; and at 150 degrees F., it becomes plastic and can be molded. Upon cooling, it again becomes non-plastic. It oxidizes when exposed to the air, changing its color and becoming brittle. The chief use of gutta-percha is for electrical insulating purposes. It appears in commerce in the forms of blocks or cakes of a grayish appearance. When used for insulation, it is shredded into warm water, kneaded, strained and rolled into sheets. It is applied to the wire that is to be insulated by special tubing machines or wound upon the wire in the form of strips. Gutta-percha may be used as an insulating material in the pure state, without admixtures of any kind. It is less porous than rubber, and is therefore more waterproof. For this reason, it is the best material to use as an insulation for submarine cables. Its specific gravity is almost exactly equal to that of water.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly on the 1st at New York, N. Y., for April 1, 1917.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of MACHINERY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press	140-148 Lafayette St., New York
Editor, Fred E. Rogers	" " " " "
Managing Editor, None	
Business Managers { Alexander Luchars, President	" " " " "
Business Managers { Matthew J. O'Neill, Gen'l Manager	" " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press	140-148 Lafayette St., New York
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "

3. That there are no bondholders, mortgagees or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 2nd day of April, 1917.

THOMAS R. WILLIAMS,
(SEAL) Notary Public, New York County, No. 254.
(My commission expires March 30, 1918.)

SPRING CONVENTION OF N. M. T. B. A.

The spring convention of the National Machine Tool Builders' Association was held in Cincinnati, May 21 and 22, the Hotel Sinton being the headquarters. President J. B. Doan, of the American Machine Tool Works, presided. On Monday morning, following the usual routine matters, a symposium on the elements of cost in machine tool building was presented under the following heads:

"Pig Iron," by James Albert Green, Matthew Addy & Co.
"Steel," by Royal Mattice, American Steel & Wire Co.
"Lumber," by S. B. Stanbery, Chicago Lumber & Coal Co.
"Supplies," by William J. Radcliffe, E. A. Kinsey Co.
"Labor," by Murray Shipley, Lodge & Shipley Machine Tool Co.
"Overhead Burden," general discussion.

Resolutions of respect were passed by standing vote for the late F. E. Reed and William Lodge.

The program for the afternoon included the following:

"Lessons and Opportunities of the World War for American Manufacturers," by William Hard, investigator and contributor to the *Metropolitan Magazine.*
"Machine Tool Protection Devices," by H. W. Dunbar, Norton Grinding Co.
"Trade Acceptances," by Z. Chafee, Diamond Machine Co.

Tuesday forenoon was devoted to meetings of standing committees and executive session. In the afternoon a joint session was held with the American Society of Mechanical Engineers, at which Dean Herman Schneider of the University of Cincinnati presented a paper, "The Human Side of Engineering," following which was "The Human Potential in Industry," by Dr. Otto P. Geier. At the close of the joint session, MACHINERY'S motion picture, showing the machining operations on the British 9.2-inch high-explosive shell, as performed in the plant of the A. P. Smith Mfg. Co., East Orange, N. J., was shown. This motion picture, which has been made under the direction of Chester L. Lucas and Victor Brook of MACHINERY'S staff, was received with great interest, as it shows in an unusually clear manner the operations and indicates the use to which motion pictures might be put in the mechanical industries for instruction purposes. The picture was accompanied by a talk by Mr. Lucas, which aided in making clear every point in the process of machining.

The smoker at the Business Men's Club, Tuesday evening, under the direction of Fred A. Geier, provided a unique entertainment greatly enjoyed by an audience that taxed the capacity of the place. Patriotic airs were played and sung, accompanied by novel lighting effects. Features were a mock trial in which some of the characteristics of prominent engineers were parodied. A short play on fitting men to their jobs took off the cooperative school work. This and other entertainments gave fresh proof of the hospitality of Cincinnati.

* * *

SPRING MEETING OF A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers was held jointly with the National Machine Tool Builders' Association in Cincinnati, May 21-24, inclusive, the Hotel Sinton being the headquarters. It was a notable meeting, coming at a time when engineers have presented to them problems that never have been placed before the engineering fraternity. The feature of the spring meeting was the session on the manufacture of munitions and related problems. Excursions were made to a number of manufacturing plants in Cincinnati, among which were the Lodge & Shipley Machine Tool Co., Cincinnati Milling Machine Co., Cincinnati Planer Co., Cincinnati Bickford Tool Co., and Lunkenheimer Co.

President Ira N. Hollis delivered an address Monday evening on the meaning of war to America and the part played by the engineer. The regular program began Tuesday morning with the presentation of the following papers:

"Tests of Uniflow Steam Traction Engines," by F. W. Marquis.
"Relation of Efficiency to Capacity in the Boiler Room," by Victor B. Phillips.
"Radiation Error in Measuring Temperature of Gases," by Henry Kreisinger and J. F. Barkley.
"Development of Scientific Methods of Management in a Manufacturing Plant," by Sanford E. Thompson, William O. Lichtner, Keppel Hall and Henry J. Guild.
"Disk-wheel Stress Determination," by S. H. Weaver.

The machine shop session followed with:

"A Foundation for Machine Tool Design and Construction," by A. L. DeLeeuw.
"Machine-shop Organization," by Fred G. Kent.
"Metal Planers and Methods of Production," by Charles Meier.

Gas power and industrial safety sessions were also held, at which these papers and drafts of codes were presented:

"The Problem of Aeroplane Engine Design," by Charles E. Lucke.
"Test of a Motor Fire Engine," by Horace Judd.
"The Design of Motor Truck Engines for Long Life," by John Younger.
"The Relation of Port Area to the Power of Gas Engines and Its Influence on Regulation," by J. R. DuPriest.
Tentative Draft of Code of Safety Standards for Industrial Ladders.
Tentative Draft of Code of Safety Standards for Power Transmission Machinery.

The spring meeting was characterized by two munitions sessions, the first being held Wednesday forenoon. The program was as follows:

Opening remarks by Lieutenant T. S. Wilkinson, Jr., U. S. N. Bureau of Ordnance.
"Munitions Contracts and Their Financing," by Frederick A. Waldron.
"Organizing for Munitions Manufacture," by Arthur L. Humphrey.
"Organization for Munitions Manufacture," by Harry L. Coe.
"Procuring Special Machines for Munitions Manufacture," by H. V. Haight.
"Practical Wartime Shell Making," by Lucien I. Yeomans.

The second munitions session, Thursday forenoon, comprised the following:

"Munitions Design for Quantity Manufacture," by J. E. Otterson.
"Procuring Materials for Munitions," by C. B. Nolte.
"Limits and Tolerances for the Manufacture of Munitions," by A. W. Erdman.
"Gages and Small Tools," by Frank O. Wells.
"The Importance of Intelligent Inspection in Munitions Manufacture," by E. T. Walsh.

The interest in the war problems confronting engineers and manufacturers was shown at the munitions sessions. The papers were discussed at length from many angles by men actively engaged in making shells, fuses and tools. The gravity of the situation is keenly realized, and cooperative effort is being made to place data at the disposal of all needing them.

* * *

CONVENTION OF AMERICAN GEAR MANUFACTURERS ASSOCIATION

The first convention of the American Gear Manufacturers' Association was held in Pittsburg, May 14 and 15, at which were present representatives from the following manufacturers:

Bilgram Machine Works, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Cincinnati Gear Co., Cincinnati, Ohio.
Crofoot Gear Works, Inc., Boston, Mass.
Earle Gear & Machine Co., Philadelphia, Pa.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Frost Gear and Forge Co., Jackson, Mich.
William Ganschow Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Hamilton Gear & Machine Co., Toronto, Canada.
Horsburgh & Scott Co., Cleveland, Ohio.
D. O. James Mfg. Co., Chicago, Ill.
W. A. Jones Foundry & Machine Co., Chicago, Ill.
Meisselbach-Catucci Mfg. Co., Newark, N. J.
Newark Gear & Machine Co., Newark, N. J.
R. D. Nuttall Co., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Pittsburg Gear & Machine Co., Pittsburg, Pa.
Simonds Mfg. Co., Pittsburg, Pa.
Van Dorn & Dutton Co., Cleveland, Ohio.

The papers presented at the meeting were:

"The Ins and Outs of an Industry Organization," by S. L. Nicholson.
"The Spiral or Curved Tooth Bevel Gear," by James E. Gleason.
"Job Gearing—to what Extent can it be Standardized," by Frank Burgess.
"Advantages of Gear Standardization," by William Ganschow.

An address was made by Phillie Gear which caused great applause and laughter. F. M. Sinram was elected president; Henry E. Eberhardt, vice-president; Frank D. Hamlin, secretary; and Frank Horsburgh, treasurer. Ten new members joined the association at the meeting.

PERSONALS

George W. Cope, editor of the *Iron Age*, has resigned and retired from business. Mr. Cope joined the editorial staff of the *Iron Age* in 1883.

Robert B. Luchars, son of Alexander Luchars, and secretary of MACHINERY, has joined the Reserve Officers Training Camp at Fort Myer, Va.

W. E. Best, for the past five years superintendent of the National Cash Register Co., Dayton, Ohio, has resigned.

William H. Blount, formerly chief draftsman with Sleeper & Hartley, Inc., Worcester, Mass., has been appointed superintendent of the company's plant No. 1 on Prescott St.

David W. Taylor, chief constructor, chief of Bureau of Construction and Repair, United States Navy, was presented with the Franklin medal by the Franklin Institute, May 16.

John G. Barry has been appointed general sales manager of the General Electric Co., Schenectady, N. Y. Mr. Barry will also continue to act as manager of the railway department.

Charles Whiting Baker has resigned as editor-in-chief of the *Engineering News-Record* of New York City, and has been succeeded by Frederick E. Schmitt. Mr. Baker will act as consulting editor.

Edwin J. Peirce, Jr., has opened offices at 253 Broadway, and is making a specialty of investigating conditions governing plants and suggesting methods whereby their production cost can be decreased.

R. F. Ingram, formerly in charge of tool purchasing with the New England Westinghouse Co., East Springfield, Mass., has joined the sales department of the Cleveland Milling Machine Co., Cleveland, Ohio.

Henry F. Russell has resigned from the sales force of the Lumen Bearing Co., Buffalo, N. Y., after a service of thirteen years, to become sales manager of the gray iron foundry division of Farrar & Treffts, Buffalo, N. Y.

Joseph W. Wunsch, a contributor to MACHINERY, has established the Paramount Pattern & Model Works, with offices at 207 Center St., New York City, for the purpose of manufacturing patterns and models, aluminum and composition castings, and experimental machinery.

F. Quattrone, chief engineer of the Italian State Railways, has arrived in the United States as a special delegate of the Italian State Railways to be attached to the Italian Embassy at Washington, and will have charge of the purchase and shipment of all materials contracted for by the Italian government.

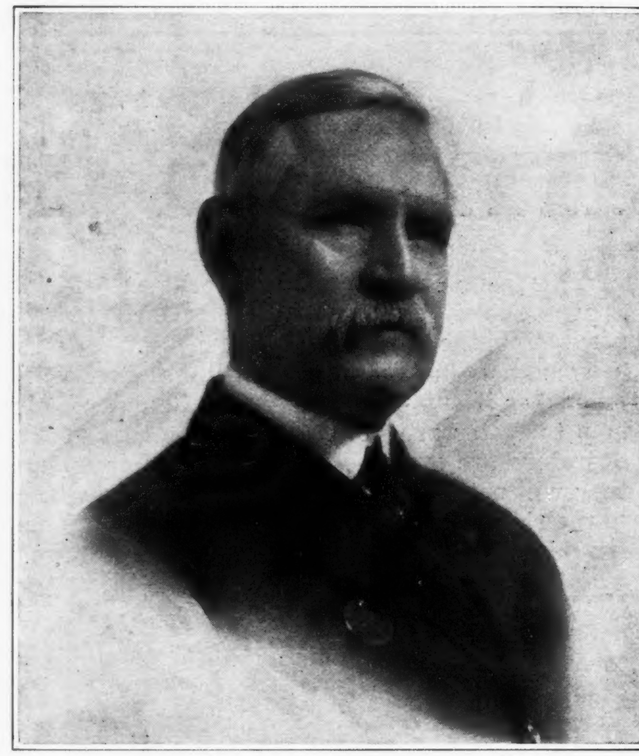
Keith R. Rodney, for many years connected with the Midvale Steel Co. and for the past two years supervisor of heat-treating with the Winchester Repeating Arms Co. of New Haven, has recently become associated with the Bullard Machine Tool Co., Bridgeport, Conn., as metallurgist and special counselor in the selection and treatment of steels.

Gustaf Akerlund, formerly chief engineer of the Standard Gas Power Co., has established a consulting and contracting engineering business in the gas producer and gas power line, in partnership with George W. Semmes, who was formerly assistant chief engineer with the Standard Gas Power Co. Their office is located at 17 Battery Place, New York City.

L. H. Metzger, formerly sales manager with Kearney & Trecker, Milwaukee, Wis., has become associated with the sales department of the Cleveland Milling Machine Co., Cleveland, Ohio. Mr. Metzger has had wide experience in machine tool sales. He has been connected with the Motch & Merryweather Co., Cleveland, and Manning, Maxwell & Moore, at St. Louis and Cleveland.

OBITUARIES

Lewis R. Pomeroy, for years a consulting engineer in the railway and electrical field, died suddenly May 7 at his home in Orange, N. J., of heart disease, aged sixty years. From 1874 to 1880 Mr. Pomeroy was engaged in commercial business as a bookkeeper, draftsman and designer of cars and locomotives; from 1880 to 1886 he was secretary and treasurer of the Suburban Rapid Transit Co. of New York City; and for the following four years was a special representative of the Carnegie Steel Co. for basic boiler steel used for locomotives and special railway forgings. Subsequently, he became connected with the Cambria Steel Co. and the Latrobe Steel Co. jointly in experimental research work. In 1899 Mr. Pomeroy went with the Schenectady Locomotive Works as assistant to A. J. Pitkin, which position he held for three years. The following six years were spent as special representative of the General Electric Co. in the mechanical railway field. Later he was assistant to the president of the Safety Car Heating & Lighting Co., and subsequently he was engaged in independent consulting work. He is survived by a son and a daughter.



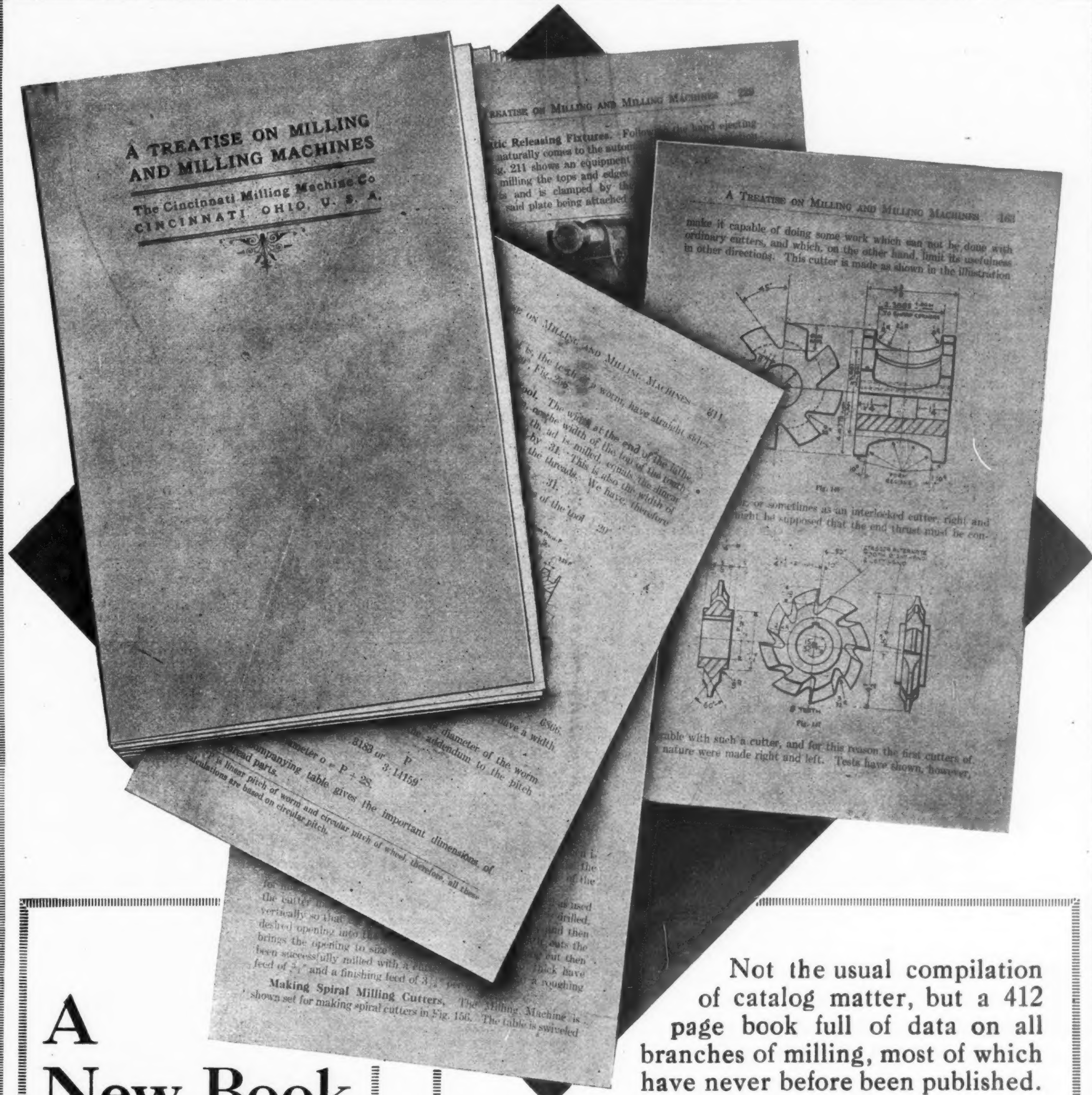
William Lodge

WILLIAM LODGE

For more than thirty-five years William Lodge was so closely associated with the machine tool industry that a history of his manifold activities during that period would almost be a history of machine tool progress in this country—and especially is this true of the development of the industry in the city of Cincinnati.

Born in Leeds, England, on May 12, 1848, Mr. Lodge had reached a vigorous old age when he died suddenly on April 30 last. Like nearly all successful mechanics, he began his life work early, starting as an apprentice in the machine shop of Fairbairn & Co. of Leeds, England, when he was fourteen. In 1869 he came to Philadelphia, and in 1872 settled in Cincinnati, with which city and its great machine tool industry he was closely identified to the day of his death. He obtained employment with John Steptoe, a well-known machine tool manufacturer of that day, with whom he remained for eight years, and then, having saved a thousand dollars, formed a partnership with William Barker and another Steptoe workman named Bechle, under the firm name of Lodge, Barker & Co., making lathes. The business made substantial and continuous progress until 1886, when the firm name was changed to Lodge, Davis & Co., Mr. Barker retiring and Mr. Davis taking his place. In 1889 the business was incorporated as the Lodge & Davis Machine Tool Co., from which Mr. Lodge retired in 1892, starting a new company under the name of the Ohio Machine Tool Co. In August, 1892, he associated himself with Mr. Murray Shipley under the name of the Lodge & Shipley Machine Tool Co., and this association and friendship continued until the day of his death.

Mr. Lodge became widely known on account of being the first, or one of the first, machine tool builders to specialize in the manufacture of a single tool instead of making several kinds, as was then the custom, and by adhering strictly to this policy he was able to produce a superior machine at a price that insured a wide and steady market. Many of the Cincinnati machine tool concerns were founded by men who were at one time employed by Mr. Lodge, or obtained their start through orders for tools or parts placed with them by his firm. Mr. Lodge's name was known wherever machine tools are used, not only because of his advanced methods of manufacturing, but on account of his whole-souled geniality and wonderful faculty of making friends, of whom he had a multitude. Mr. Lodge never forgot the days when he was a workman, and for that reason was especially successful in handling his employes. He was a member of the Queen City, Commercial, Engineers' and Business Men's Clubs, the American Society of Mechanical Engineers, the Machinery Club of New York, and was a thirty-second degree Mason. Mr. Lodge was one of the organizers of the Machine Tool Builders' Association, which was formed at a meeting in New York, June 12, 1901, and was its second president.



A New Book on Milling

Not the usual compilation of catalog matter, but a 412 page book full of data on all branches of milling, most of which have never before been published. Tells you just what you want to know about the latest practice in—

Speeds and Feeds; Cutter Design; Jigs and Fixtures; The Best Method for Milling a Given Job; Power Required to Do Milling; Size of Cut Each Machine Can Take; How to Set Up for the Best Results; Cutter Sharpening; Chattering—its causes and remedies.

Use of the Dividing Head—and a complete, simple discussion of the mathematics of Spur, Bevel, Mitre, Spiral and Worm Gear Cutting, Angular Indexing, Computing Change Gears, Etc.

Complete Tables for Indexing, Spiral Milling, Cam Milling, Rack Milling, Trigonometric Functions, Etc.

Invaluable to the superintendent, foreman, milling machine operator and draftsman.

Price $1.50 Postage Prepaid.

One of the hundred unsolicited testimonials we have received says:—

"This is the most complete work it has been my privilege to find on this particular subject."

The

Cincinnati Milling Machine Company

Cincinnati, Ohio, U. S. A.

COMING EVENTS

June 11-12—Annual meeting of the Electric Power Club in Washington, D. C.; New Willard Hotel, headquarters. C. H. Roth, secretary, 1410 W. Adams St., Chicago, Ill.

June 12-15—Summer meeting of American Society of Civil Engineers in the "Twin Cities," Minneapolis and St. Paul; Radisson Hotel, headquarters.

June 20-22—Semi-annual meeting of American Institute of Chemical Engineers in Buffalo, N. Y. J. C. Olson, secretary, Cooper Union, New York City.

June 23-30—Industrial exposition and export conference at Springfield, Mass. John C. Simpson, general manager.

June 25-26—Summer meeting of the Society of Automotive Engineers at the Bureau of Standards, Washington, D. C.

June 25-30—Annual convention of American Institute of Electrical Engineers in Hot Springs, Va.; Homestead Hotel, headquarters. F. L. Hutchinson, secretary, 29 W. 39th St., New York City.

June 26-30—Annual meeting of American Society for Testing Materials in Atlantic City, N. J. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

June 28—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

August 30-September 1—Ninth annual convention of the American Railway Tool Foreman's Association, Chicago, Ill.; Sherman Hotel, headquarters. C. N. Thulin, secretary-treasurer, 935 Peoples Gas Bldg., Chicago, Ill.

September 10-15—Annual convention of the National Safety Council, New York City; Hotel Astor, headquarters. Marcus A. Dow, president, Grand Central Station, New York City.

September 10-15—Exposition of safety appliances at the Grand Central Palace, New York City, under the auspices of the American Museum of Safety, 18 W. 24th St., New York City. Arthur H. Young, director.

SOCIETIES, SCHOOLS AND COLLEGES

University of Vermont, Burlington, Vt. Catalogue for 1916-1917, with announcements for 1917-1918.

Newberry College, Newberry, S. C. Catalogue for the sixtieth session, 1916-1917, and announcements for 1917-1918.

University of Missouri, School of Mines and Metallurgy, Rolla, Mo. Catalogue 1916-1917, with calendar for 1917-1918.

Hebrew Technical Institute, Stuyvesant and 9th Sts., New York City. Annual report of the institute for the year 1916.

Hebrew Technical Institute, Stuyvesant and 9th Sts., New York City. Catalogue for 1917, giving the courses of instruction, conditions of admission, etc.

New York University, New York City. Preliminary announcements of the day and evening sessions of the School of Commerce, Accounts and Finance for 1917-1918.

International Correspondence Schools, Scranton, Pa. Booklet entitled "A Solution of the Vocational-Education Problem," describing the educational methods of the International Correspondence Schools.

Railway Car Manufacturers' Association has opened an office in Room 2216 at 61 Broadway, New York City. Dr. W. F. M. Goss, formerly dean of the College of Engineering of the University of Illinois, is the president.

Franklin Institute, Philadelphia, Pa., has awarded Franklin medals to Hendrik Antoon Lorentz, president of the Royal Academy of Sciences, Amsterdam, and to David Watson Taylor, chief of the Bureau of Construction and Repair, United States Navy.

Louisiana State University, Baton Rouge, La. Catalogue 1917, containing general information relating to the university, admission requirements, outlines of courses of the college of agriculture and engineering, and announcements for the year 1917-1918.

Lowell Textile School, Lowell, Mass. Bulletin for the year 1917-1918, containing a brief description of the Lowell Textile School and its equipment, an outline of the courses, and the subjects required for entrance, as well as a register of the day students during the term 1916-1917.

Providence Engineering Society, Providence, R. I., gave its second annual dinner in Providence, May 2, to about 400 people, including the leading engineers of Rhode Island. The dinner was a patriotic affair; the speakers dwelt upon the part played by engineers in war, the need of conserving resources and improving the efficiency of industries, etc.

NEW BOOKS AND PAMPHLETS

Report on the Price of Gasoline in 1915. 224 pages, 6 by 9 inches. Published by the Federal Trade Commission, Washington, D. C.

Temperature Measurements in Bessemer and Open-hearth Practice. By George K. Burgess. 29 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 91.

Structure of the Coating on Tinned Sheet Copper in Relation to a Specific Case of Corrosion. By Paul D. Merica. 18 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 90.

Facts and Fallacies of Compulsory Health Insurance. By Frederick L. Hoffman, statistician of the Prudential Insurance Co., Newark, N. J., being an address read in part before the section on social and economic science of the American Association for the Advancement of Science, December 28, 1916, and the National Civic Federation, January 22, 1917. Published by the Prudential Insurance Co., Newark, N. J.

Storage Batteries Simplified—Operating Principles—Care and Industrial Applications. By Victor W. Page. 208 pages, 5 by 7¼ inches; 89 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $1.50.

The book is a non-technical treatise on the development of the modern storage battery, outlining the principle of operation of the leading types and the methods of construction, charging, maintenance and repair. A glossary of storage battery terms is included.

The Driving of Machine Tools. By Thomas R. Shaw. 221 pages, 4½ by 7¼ inches; 139 illustrations. Published by Scott, Greenwood & Son, London, England, and D. Van Nostrand Co., New York City. Price, $2.

This book is based on a series of lectures on machine tools given by the author at the Royal Technical Institute, Salford, and its object is to give some simple and rational methods of arranging a drive to give the desired results and to include such formulas, rules and data as are required. After discussing the importance of durability of machine tools and accessibility of construction, the author takes up cone pulleys and gearing, applications of the cone pulley, characteristics of all-geared drive, applications of electric motor drive, the peculiarities of planing machine drives, drives for various machine tools and miscellaneous matters. The work contains a large amount of valuable information and data pertaining to machine tool drives in small compass.

Organization in Accident Prevention. By Sydney W. Ashe. 130 pages, 6 by 9 inches; 76 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $1.50.

The aim of this book is the development of the "safety habit" by the employes, and the opening chapter tells how this may be obtained through fellowship, system, education and discipline. Special emphasis is laid on the need of education, but it is pointed out that before a suitable educational course can be laid out, the accident data of the company must be systematized and studied. About one-half of the book is devoted to specific accidents that may be reduced in number; then come discussions of the medical and physical examinations of employes, with special reference to tuberculosis and hernia, and emergency hospitals and first aid; then the methods of keeping accident records, analyzing them, and the drawing of ratio curves are described, after which accident relationships are discussed. It is stated that the best safety habits are found among workers approximately thirty-seven years of age, that the tendency to accidents is greatest between 9 and 10 o'clock in the morning, and that in this country Monday is the worst day of the week.

A Preliminary Study of the Alloys of Chromium, Copper and Nickel. By D. F. McFarland and O. E. Harder. 60 pages, 6 by 9 inches; 68 illustrations. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin 93. Price, 30 cents.

The growing interest in special acid-resisting alloys and the many uses found for them have stimulated both the search for efficient materials of this nature and the causes underlying their inertness. As a result of previous studies at the University of Illinois, it has been shown that the almost perfect insolubility of certain alloys in nitric and other acids seems to be conditioned upon a proper mixture of chromium, copper and nickel, together with smaller quantities of such added metals as tungsten or molybdenum. As a result of the studies, methods have been developed for making castings of alloys of chromium, copper and nickel. More than 300 corrosion tests have been made to measure the effects of acids upon the metals. In general, the results indicate that certain of the alloys of chromium, copper and nickel give promise of becoming of great commercial importance, not only in the construction of laboratory apparatus, but in manufacturing and chemical processes.

NEW CATALOGUES AND CIRCULARS

Link-Belt Co., Chicago, Ill. Catalogue 260 on link-belt and sprocket wheels for sawmills.

Scovill Mfg. Co., Waterbury, Conn. Annual report of accident statistics for the year 1916

Enterprise Machine Works, 115 W. Redondo St., Los Angeles, Cal. Circular giving general specifications of the Enterprise electric industrial floor trucks and tractors.

Link-Belt Co., Chicago, Ill., is distributing a wall hanger printed in colors containing a portion of President Wilson's proclamation. Copies will be sent on request.

Lamb Knitting Machine Co., Chicopee Falls, Mass. Circular of the Lamb grinder provided with self-aligning, double-row ball bearings and the Lamb automatic oiling system.

Cooper Hewitt Electric Co., 8th and Grand Sts., Hoboken, N. J. Bulletin 67, giving specifications for types P, L, H and K indoor electric lamps for use with direct current.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Catalogue in Spanish of the J. H. Williams wrenches, lathe tools, cutting-off tools, threading tools, dogs, and clamps.

Link-Belt Co., Chicago, Ill. Booklet 303, entitled "Some Modern Coal Tipples," describing equipment installed by the Link-Belt Co. at the plants of various coal and coke companies.

Cooper Hewitt Electric Co., 8th and Grand Sts., Hoboken, N. J. Bulletin 66, giving specifications for Cooper-Hewitt types E and F indoor electric lamps, for use with alternating current.

Link-Belt Co., Chicago, Ill. Catalogue 305, containing an article on "Traveling Water Screens for Condenser Intakes," by Henry J. Edsall, which was reprinted from the "Practical Engineer."

Stow Mfg. Co., Binghamton, N. Y. Miniature bulletins 101 and 102 on flexible shaft and electric tools, respectively. These bulletins are the same as the regular catalogues, but are issued in small sizes for convenience.

Ready Tool Co., Bridgeport, Conn. Circular of welded "Stellite" lathe tools, consisting of "Stellite" tips welded to machine steel shanks, thus giving the user the advantages of a solid forged high-speed tool at comparatively low cost.

North Side Tool Works, Dayton, Ohio. Circular of "Universal" amplifying gages for gaging tool and production work. The gages are made with attachments and fixtures to suit them to all conditions and classes of work within their capacity.

Albany Lubricating Co., 708-710 Washington St., New York City, issues a monthly publication called "The Bearing," treating of the lubrication of bearings of various kinds, with especial reference to the use of "Albany" grease and "Albany" grease cups.

Onondaga Steel Co., Syracuse, N. Y. Circular on the "Onondaga" process for converting high-speed steel odds and ends into new high-speed steel. The economic importance of the process at the present time, when tungsten is scarce and high priced, is obvious.

General Electric Co., Schenectady, N. Y. Bulletin 43503, entitled "The Application of 'Novalux' Units to Ornamental Street Lighting," containing thirty-six pages of illustrations showing lighting units for business streets, residential streets and outlying districts.

Royal Mfg. Co., Rahway, N. J. Booklet entitled "Producing the Fittest in Waste," relating to cotton waste of the quality handled by the company. The booklet describes the method of sorting, grading, mixing, pulling, screening, and handling waste for the machinery trades.

Link-Belt Co., Chicago, Ill. Bulletin 253, entitled "The Ideal Drive for Cement Mill Equipment," describing the large Link-Belt silent chain drive installed at the plant of the Nazareth Cement Co., Nazareth, Pa., which consists of 32 Link-Belt silent chain drives, totalling 3500 horsepower.

Sleeper & Hartley, Inc., 68 Prescott St., Worcester, Mass. Bulletin 269 on wire nail machines which are so designed and constructed as to produce wire nails from a coil at much greater speeds than have heretofore been possible, and with a great reduction of noise characteristic of wire nail making machines in general.

Columbian Hardware Co., Cleveland, Ohio. Catalogue of Columbian vises and anvils. The catalogue comprises 36 pages, illustrating, describing and giving dimensions of blacksmiths' vises, arsenal vises, hand vises, clip horn anvils, blacksmiths' anvils, machinists' vises, gage-makers' vises, pipe vises, and patternmakers' vises.

Barnes Drill Co., 814 Chestnut St., Rockford, Ill. Catalogue of Barnes self-oiling, all-geared drilling and tapping machines. These machines are made in sizes of 20, 22, 24 and 26 inches. In addition to the single-spindle type, these machines are also made in the gang type with from two to six spindles mounted on one base.

Goodell-Pratt Co., Greenfield, Mass. Tool book 13, showing more than 1500 tools made by this company, among which are drills, punches, adjustable wrenches, screwdrivers, awls, bits, levels, drill chucks, ratchet bit braces, speed indicators, universal calipers, tool sets, hacksaw blades and frames, polishing and grinding heads, rules, etc.

New Departure Mfg. Co., Bristol, Conn. Sheets Nos. 95 FE to 98 FE, inclusive, for loose-leaf catalogue, showing the application of ball bearings to friction clutch for lineshaft pulley, the remodeling of plain bearing equipment, use of ball bearings in the electrical drive for elevator worm-gearing, and ball bearings for vertical shaft and drive pulley support.

American Steel Export Co., Woolworth Bldg., New York City. Booklet entitled "Export Engineering and Contracting," advertising the service which the company is in a position to render. Estimates, designs and equipment are furnished for a large line of different kinds of machinery, including mining, paper mill, saw mill, welding, foundry, and special machinery.

Cooper Hewitt Electric Co., 8th and Grand Sts., Hoboken, N. J. Bulletin entitled "Economics of Industrial Lighting," which comprises a treatise on the application of the principles of illuminating engineering to the lighting of factories, shops and works. The book is illustrated with views of factory in-

teriors showing the illumination obtained with Cooper-Hewitt electric lights.

Springfield Grinding Co., Chester, Mass. Catalogue of "MaxF" grinding wheels, giving price lists for straight wheels, taper wheels, cup wheels, cylinder wheels, and special shaped wheels. "MaxF" wheels are manufactured by four different processes, namely, vitrified, silicate, elastic and vulcanite. Tables of grades indicating the various degrees of hardness of these wheels and tables for selecting the grades are included.

Bradford-Ackermann Corporation, Forty-second St. Bldg., New York City. Bulletin 101 on "Astra" oxy-illuminating gas apparatus for lead burning. The apparatus was developed with the needs of storage battery manufacturers and service stations in view. It makes possible the use of artificial or natural illuminating gas drawn directly from the mains in connection with tanked oxygen for lead burning or welding.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 3311, covering the "Imperial" type X duplex steam-driven compressors suitable for general industrial application of compressed air. The catalogue gives tables of sizes and capacities. Form 8507, descriptive of "Little David" pneumatic drills, showing a large number of types and sizes and giving recommendations for the particular type of work for which each is adapted.

Thomas Elevator Co., 22 S. Hoyne Ave., Chicago, Ill. Bulletins on the "Barker" wrench and wrenchless chucks, illustrating construction, application and use. The wrenchless chuck is so designed that it can be used on any engine lathe, and means are provided by which the rotation of the spindle is caused to close or open the jaws, thus saving the strength and time of the operator and insuring a powerful grip on the work.

Greenfield Tap & Die Corporation, Greenfield, Mass., has issued a manual containing instructions for the use of its employes. It contains information concerning pay regulations, absence from work, use of materials, machines and tools, workmen's compensation act, dining-room service, house and room register, benefit associations, library, educational classes, employment department, sanitation and health, social and athletic interests, etc.

Hyatt Roller Bearing Co., Newark, N. J. Engineering bulletin 408 on Hyatt roller bearings for drilling machines. The data given will enable the manufacturer and designer of drilling machines to select the correct size and type of bearings and to provide for their proper housing. Tables of dimensions of high-duty bearings and planished race type bearings are given, and the application of these bearings is clearly illustrated by line drawings.

Link-Belt Co., Chicago, Ill. Data book 125 on the "Link-Belt Silent Chain," bound in flexible leather covers. The book contains 128 pages, 6 by 9¾ inches, showing numerous illustrations of the application of Link-Belt silent chain for the transmission of power. Over 200,000 installations have been drawn on for the information presented. Tables of data that should be of considerable value to engineers and users of power in selecting drives are included.

Webster & Perks Tool Co., Springfield, Ohio. Circular of No. 1 grinder, floor or bench type. The company is also distributing a convenient pocket slide-rule for grinding wheel operators. On one side is given a table of circumferences in feet for wheel diameters in inches, and on the other side a table of grinding wheel speeds for wheel diameters in inches and millimeters for surface speeds of 4000, 5000 and 6000 feet. This convenient slide-rule makes the calculation of grinding wheel speeds for any diameter and speed ordinarily used a quick and easy matter.

Tate-Jones & Co., Inc., Pittsburg, Pa. Booklet entitled "Heat-treatment of Steel," which is intended as a reference book of formulas, heat-treating methods and general information. The book has been made brief and compact, and is written in a simple, untechnical style, for the use of shopmen. The subjects covered are annealing, hardening, tempering, cooling baths, scaling, hardening heats and tempering heats. The section headed "Different Thermometer Temperatures" gives rules for changing Fahrenheit to Centigrade, Fahrenheit to Reaumur, Centigrade to Reaumur, and vice versa.

Fellows Gear Shaper Co., Springfield, Vt. Treatise entitled "Commercial Gear Cutting." This book, covering 93 pages, 6 by 9 inches, gives a complete and well illustrated description of modern commercial gear cutting, dealing particularly with the production of spur, helical, and internal gears on the Fellows gear shaper. The book is divided into ten chapters, entitled: Profit the Final Test; The Gear Shaper Cutter and How It Works; Generating a Cutter; Comparisons; The Generated Cutter at Work; The Essentials of Profit in Gear Cutting; Description of No. 6 Fellows Gear Shaper; Description of No. 65 Helical Gear Shaper; Description of Different Sizes of Gear Shapers; A Few Examples of Work Cut on the Gear Shaper. Throughout the text there are sixty-four halftone and line engravings, the latter, especially, being exceedingly clear and provided with explanatory descriptive matter, making it easy to grasp the construction of the machine.

American Steel Export Co., Woolworth Bldg., New York City, is distributing copies of a reprint from the "Iron Trade Review" of an article by Samuel A. Benner, entitled "What Peace Means to Steel Trade." Mr. Benner refers to the fact that for over two years the United States has occupied the unique position of being the only country able to supply iron and steel for the international markets. Following the end of the war there will be some demand from Europe for steel for reconstruction purposes, but this demand will not be great nor for long. There will be a demand for constructive work in the United States and the replenishment of stocks everywhere, following which will be the resumption of active foreign competition. Mr. Benner points to the important need of cooperation of manufacturers to reach foreign buyers and supports the Webb bill, which would permit cooperation between American manufacturers without violation of the anti-trust laws.

TRADE NOTES

Oxy-acetylene Products Co. has moved from Chicago, Ill., to 630 Brooklyn Ave., Kansas City, Mo.

Cincinnati Lubricant Pump Co., 125 Opera Place, Cincinnati, Ohio, has changed its name to Fulflo Pump Co.

Herman A. Holz has moved from 50 Church St. to the Metropolitan Tower, 1 Madison Ave., New York City.

Zenite Metal Co., Indianapolis, Ind., is building a large addition to its factory and is installing enough new presses to double its present capacity for stamped steel work.

Wilmarth & Morman Co., 1180 Monroe Ave., N.W., Grand Rapids, Mich., manufacturer of grinding machines, is making a two-story brick and steel addition to its plant, 74 by 84 feet.

Hyatt Roller Bearing Co., Newark, N. J., has advanced the prices of Hyatt flexible roller bearings, owing to the advance in the cost of materials and the higher wages paid to workmen.

New Departure Mfg. Co., Bristol, Conn., has erected a steel and concrete building, four stories high, 220 by 250 feet, which will be devoted exclusively to the manufacture of steel balls. The total floor space in the building is 178,000 square feet, or nearly 4½ acres.

T. A. Willson & Co., Inc., 3rd and Washington Sts., Reading, Pa., recently filled an order for army goggles for the United States government. An order has also been placed with this company by the British government for industrial goggles to be used by field troops and by industrial workers at home.

August Mietz Corporation, 128-138 Mott St., New York City, announces that the business of August Mietz has been sold and transferred to the August Mietz Corporation. The officers are Emma C. Rueff, president; Emil Rueff, vice-president and treasurer; Otto V. Schrenk, secretary; and Louis C. Eitzen, general manager.

Sprague Electric Works, 527-531 W. 34th St., New York City, is erecting a new reinforced concrete machine shop at Bloomfield, N. J. The main building is six stories in height, 75 by 550 feet, with an ell 75 by 179 feet, the walls of which are faced with brick. The work is being done by John W. Ferguson Co., Paterson, N. J.

Lapointe Machine Tool Co., Hudson, Mass., is constructing an addition to its main building, 40 by 100 feet, two stories high; a one-story addition, 10 by 40 feet, to its hardening room, and a one-story addition, 32 by 60 feet, to its shipping room, all to be made of brick. The contract has been let to the J. J. Prindiville Co., Framingham, Mass.

Goodell-Pratt Co., Greenfield, Mass., is erecting a new building, four stories high, of reinforced concrete construction throughout. The building will be 58 by 260 feet, with a four-story ell 58 by 110 feet, and will increase the floor area of the concern by more than 86,000 square feet. The work is being done by the Aberthaw Construction Co., Boston, Mass.

Bound Brook Oil-less Bearing Co., Bound Brook, N. J., has awarded the contract for a new foundry to be erected at Lincoln, N. J., two miles east of the Bound Brook plant. The new building will be of steel and brick construction, 60 feet wide by 180 feet long. It will be two stories high and modern in every respect. This addition has been made necessary by the rapidly increasing business of the firm.

Sleeper & Hartley, Inc., 68 Prescott St., Worcester, Mass., designer and builder of automatic wire coiling machinery, has leased additional manufacturing space in Worcester, and has begun the construction of a new plant to be devoted entirely to the manufacture of improved wire nail machinery. A. L. Lewis, formerly superintendent of the company's present plant, will take charge as superintendent of the new plant.

Boris V. Constantinov, 29 Broadway, New York City, mechanical engineer, has for the past two years been establishing connections with firms and private individuals in Russia and Siberia, and studying the needs of the Russian market. He is prepared to make arrangements with non-competitive firms for distributing their goods in Russia, and to act as a representative. Mr. Constantinov will open a general office in Moscow.

American Steel Export Co., Woolworth Bldg., New York City, has appointed Charles S. Vought assistant manager of sales. Mr. Vought was formerly one of the managers of the order department of the Cambria Steel Co. and is well fitted to fill the position and responsibilities of his new position, having familiarity not only with the various export markets of the world, but also knowledge of mill conditions and the technicalities of the production of steel.

S. K. F. Ball Bearing Co., Hartford, Conn., announces that the S. K. F. Ball Bearing Co. of California, Inc., has been organized in order to more readily supply the rapidly increasing demand for S. K. F. bearings on the Pacific coast. The main office of the company, under the direction of A. M. MacLaren, has been opened at 341 Larkin St., San Francisco, where a large stock of S. K. F. bearings will be carried. Engineering service will also be available.

S. K. F. Administrative Co. has been formed to manage the Hess-Bright Mfg. Co. of Philadelphia and the S. K. F. Ball Bearing Co. The directorate of the S. K. F. Administrative Co. consists of Frank A. Vanderlip, Thatcher Brown, F. B. Kirkbride, S. Wingquist, Alexander Carlander, Marcus Wallenberg, a banker of Sweden, and B. G. Prytz, president of the S. K. F. Ball Bearing Co. Plans are being made for increasing the plant facilities of the organization.

Fostoria Press Steel Co., Fostoria, Ohio, has been incorporated at $100,000, and will make all the pressed steel parts required by the Allen Motor Co. The plant will turn out complete sheet metal products, enameled and japanned. The factory will have 20,000 square feet of floor space and will be of fireproof brick construction. The officers of the new corporation are Henry Rothrock, president; George E. Kirk, vice-president; E. C. Wolfe, secretary; and C. D. Pifer, treasurer and general manager.

Hoover Steel Ball Co., Ann Arbor, Mich., will erect three new buildings and equip them with machinery to increase the production from 25,000,000 to 40,000,000 balls per day. The entire expansion in 1917 means an investment of $250,000. The buildings will be of brick and concrete construction and of the same type erected heretofore. An idea of the rapid growth of the company's business is indicated by the fact that the production has increased approximately 800 per cent within the past three years.

Lewis-Shepard Co., Boston, Mass., has moved from 262-280 Dover St. to 48 Binford St., South Boston, where quarters affording about 4000 square feet of floor space are provided. The company has purchased sixteen new machines, including drilling machines, grinders, lathes and a screw machine; it has also added to its equipment of small tools and fixtures. The larger quarters and increased tool equipment will facilitate the manufacture of the company's "Jacklift" master truck, which is classified as an elevating truck.

American Forge & Machine Co., Canton, Ohio, has announced a general wage increase of 10 per cent in all departments, taking effect May 1. This makes a total increase of 30 per cent during the past year, in addition to bonuses; the bonus plan gives each workman who has been in the employ of the company additional pay at the end of three months, six months and up to ten years. The company is turning out forgings from ½ pound to 15 tons in weight, and has recently installed some new equipment in the way of large hammers and presses to take care of its constantly increasing business.

Lincoln-Williams Twist Drill Co., Taunton, Mass., has increased its capitalization from $200,000 to $1,000,000, and will largely increase its manufacturing facilities. The name of the company has been changed to Lincoln Twist Drill Co. The president is Frederick H. Payne; vice-president and general manager, Edward Blake, Jr.; treasurer, James H. Ball. Alfred L. Lincoln, who has retired from active management, retains a position as director and owns a large stock interest in the company. Mr. Blake, vice-president and general manager, will be the active head of the factory.

Independent Pneumatic Tool Co., Chicago, Ill., announces the election of John D. Hurley, president, to succeed the late James B. Brady. Mr. Hurley has been vice-president of the company since its organization, and is well known in the pneumatic tool business, having been identified with the industry since pneumatic tools were first placed on the market. Ralph S. Cooper, who has been the manager of the New York office for the past twelve years, was elected vice-president, and Robert T. Scott, manager of the company's Pittsburg branch, was elected a director and member of the executive committee.

Michigan Tool Co., 268 E. Jefferson Ave., Detroit, Mich., manufacturer of high-grade milling cutters, hobs, dies, tools, jigs and fixtures, has increased its capital stock from $25,000 to $70,000, which is all paid in. The officers of the company are D. R. Peterson, president; Robert H. Anderson, vice-president; S. F. Wall, secretary and treasurer; T. M. Olson, general manager; and Otto Lundell, superintendent. All the members of the firm have had years of extensive experience as specialists in the manufacture of small tools and labor-saving devices. The factory is equipped with the most modern standard tools, as well as special machines and devices of their own invention.

Municipal Civil Service Commission, New York City, announces an examination for mechanical engineer, Grade D, for which applications will be received at Room 1400, Municipal Bldg., until June 13 at 4 P. M. The examination will consist of three subjects: technical, 5; experience, 3; mathematics, 2. Suitable credit will be given to graduates of technical schools of recognized standing. The duties are to perform engineering work in connection with power or heating plants, the mechanical equipment of building, or the design of machinery. The positions pay salaries from $1800 to $2400 per annum. The engineering service of the city offers excellent opportunities for advancement, paying a salary as high as $3000 a year. For further particulars apply to the Municipal Civil Service Commission, Municipal Bldg., New York City.

Walter Kidde & Co., 140 Cedar St., New York City, has been incorporated to carry on the engineering-construction business established in 1900 by Walter Kidde. The company undertakes the entire construction and equipment of factories, producing finished plants ready for operation. The organization includes departments of construction, hydraulics, steam and mechanical engineering, electrical engineering and chemical engineering. The officers are Walter Kidde, president; B. G. Worth, vice-president; I. R. Lewis, secretary and treasurer. The board of directors includes, in addition to the officers of the company, Henry Lang, vice-president of the Ingersoll-Rand Co., and E. S. Boyer, of the American Hard Rubber Co. The engineering board is composed of A. B. Miller, Walter S. Wainwright, M. I. Buttfield, and E. Schwarz. Thorlief Hiflet is chief draftsman.